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POWER

FRED R. LOW, *Editor*

Irving Fellner
Publishing Director

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He Picked up a Broom

WE HAVE all read the story of the boy who got a start upon a brilliant career after many failures to land a job, because he picked up a pin on his way out after the last refusal.

There was also another story of the rich young man who put a broom in the way of several prospects and chose for his wife the one who picked it up rather than one of those who stepped over it or kicked it aside.

I heard recently a story from real life of a man who got a job by picking up a broom.

He had applied for work and been told that there was "no opening at present." On his way out he stumbled over a broom, picked it up and stood it neatly in a corner.

The action pleased the proprietor, who called him back and told the manager to put him to work somewhere. So they put him in the power plant.

The proprietor kept up a patronizing interest in him, and he became a steam engineer of more than usual ability.

In fact, the interest and confidence of the proprietor in him were such that he was allowed to make changes over the head of the plant manager which resulted in an annual saving of several times the amount of his salary.

He did not, like the hero of the pin story, marry the old man's daughter, inherit the works and live happily ever after; but he did attain to a position of responsibility and enjoyed the friendship and confidence of his employer as long as he lived.

All because he picked up a broom and kept on practicing the habits of order which impelled him to do it.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

The New Year and the New Economics

DELVING into the causes underlying the present prosperous condition of the United States, economists conclude that the condition is due to the increasing rate of production per man, providing an abundance of low-priced goods, coupled with increasing wage rates, enabling the goods to be consumed. While this thesis is not generally accepted, there seems to be a sufficient basis of fact behind it to justify it.

Prosperity so based is essentially a circle. There is no possibility of maintaining increasing production rates if the things produced are not consumed. Consumption cannot meet this demand unless total wages paid increase enough to permit the consumers to purchase what is produced. Wages cannot do this unless production per man is constantly increasing, because the sum paid out for wages and material (which in turn represents wages) must be less than the sum taken in for the goods produced, else the venture must fail.

Perhaps it would be better to call this prosperity a spiral rather than a circle, for the level must constantly rise. Heretofore it has risen because means have continually been found to increase the productivity of man's labor. Power has multiplied man's strength, while machines have served as extra hands with which to apply the power. New processes and materials have made these efforts more productive.

There is every prospect for an increase in man's productivity in 1929, as in 1928. Research activities and engineering advances forecast increasing output for many years to come. The disposal of this flood of things demands increasing consumption. Increasing consumption depends upon the wage level being raised high enough so that more goods can be purchased.

There is, perhaps, a limit to which this cycle can go. Certainly, if wages are not sufficient to do their work, the whole structure is likely to fall. If the new economics fit conditions, as seems, then it becomes incumbent upon industry to see that the new year does not find wages lagging behind production and consumption in the general upward path.

Better Use of Byproduct Power

THE University of North Carolina installed its first boiler plant in 1858 and at frequent intervals since then has increased its capacity with modern equipment. The recent improvement program, described in an article in this issue, added a generating unit to the plant, through which steam is supplied for building heating. The generating unit furnishes the electric service for both the university and the small town of Chapel Hill.

Even though the major demand for exhaust steam is only during the winter months, the installation of equipment for generating byproduct power has proved a profitable investment. Imagine how much greater the investment returns would be in the case of an industrial plant where the demand for process steam is nearly constant throughout the year!

In spite of this, many industrial plants requiring large quantities of steam for manufacturing processes and building heating initially install boiler plants, but purchase electric energy for lighting and other power purposes. This is frequently done because steam service is not available, while electric service is and because of the desire to put all the available capital in the manufacturing plant.

If it pays to change over, as was done at Chapel Hill, how much more justified is the investment in generating equipment for a new installation!

A Challenge!

AMERICAN engineers are inclined to be proud of their achievements in the construction of steam-electric central stations. Without doubt they have built some of the finest and best plants in the world and have much reason to be proud of these. Power costs in America are among the lowest in the world. All these attainments tend to make our engineers rather self-satisfied and to encourage the idea that possibly the limit has been reached in ways and means of power production.

It is therefore a matter of more than passing interest that a challenge to power engineers to strive for even better performance should have been recently uttered by one of the leaders in engineering in England. In his paper before the recent World's Power Conference Sir Arthur Duckham said:

> Very low costs will be obtained at these new central stations, but over-all thermal efficiencies of only twenty-five per cent will be attained. The great invention that yet lies dormant is the development of prime movers to give fifty, sixty and eighty per cent efficiency. It would seem that technicians have accepted approximately the present limits and concern themselves with one-half or one per cent increases in efficiency instead of all going out for some radical change in principles and the achievement of something more nearly approaching the ultimate in changing the form of the energy from dormant in the fuel to active in steam and electricity.

Will an American engineer answer this challenge by developing an entirely new method of power or electrical development? Along what possible lines will this occur? Have some principles of chemistry or physics already

well known been overlooked in their industrial application?

Here are some new suggestions to stir the imaginations of engineers who long to do something new. The challenge cannot remain unanswered if America is to retain her pre-eminent position of leadership in power generation. Who will meet the challenge and how?

When Disaster Is a Blessing

THE War cost Germany her fleet of merchant ships, but today her merchant marine is greater than ever. More important, her ships are modern to the last detail.

A great fire once swept Chicago; an earthquake leveled San Francisco. The two cities rose finer and greater from their staggering disasters. Wandering cows, it has been said, wore the sinuous paths that eventually became the principal business streets of modern Boston. Picturesque though they be, these winding narrow streets impede business and cause losses that total millions annually. Would not Boston be an even greater business center today if some great disaster had made it easier for her to rebuild on geometric lines?

Many an industrial power plant is cursed with obsolete equipment that won't wear out and with executives who lack the courage to junk wasteful machines. Would not such plants profit from a disaster that would wipe out the power plant and force a new deal? Certainly, when new equipment, as is often the case, will yield twenty-five to fifty per cent on the investment, it is economic folly to keep on operating the old, however smoothly it may run.

Boulder Dam Includes Many Interests

WHEN President Coolidge signed the Boulder Dam bill, he brought to a close the first chapter in a long-drawn fight that involved many factors. Concerned in the development are seven states, the governments of the United States and Mexico, besides power, flood-control, municipal-water-supply, irrigation and reclamation interests. Add to these the scheming of politicians and others trying to manufacture issues to forward their own selfish ends, and it is little wonder that the struggle has been prolonged.

The signing of the bill provides Federal authority for the construction of the project, but the Colorado River Compact must be signed by Arizona before the act can become effective. Up to the present time Arizona has consistently refused to sign the compact entered into seven years ago by a commission appointed by the seven Colorado basin states. The day before the bill was signed, the Arizona legislature passed a memorial addressed to President Coolidge, requesting him to veto the bill. If this is an indication of Arizona's future attitude, a protracted delay may ensue before work on Boulder Dam is actually started.

The measure provides that the government shall supply one hundred and sixty-five million dollars, estimated as necessary to construct a dam and accompanying work in Black Canyon. This money is to be repaid under an amortization plan from the proceeds of the sale of power.

Just why the power development should pay the entire cost, while the other interests go free, is difficult to understand. The power available is estimated at one million horsepower. These figures indicate that if the power development must carry the total cost, it will be expensive. The nearest large market for it is three hundred miles away. This is now supplied by low-cost power. How Boulder Dam power, if it is to carry the total cost of the project, can compete, there becomes a mystery. It may be that those who believe that water-power is something from which dollars just flow can solve this economic puzzle.

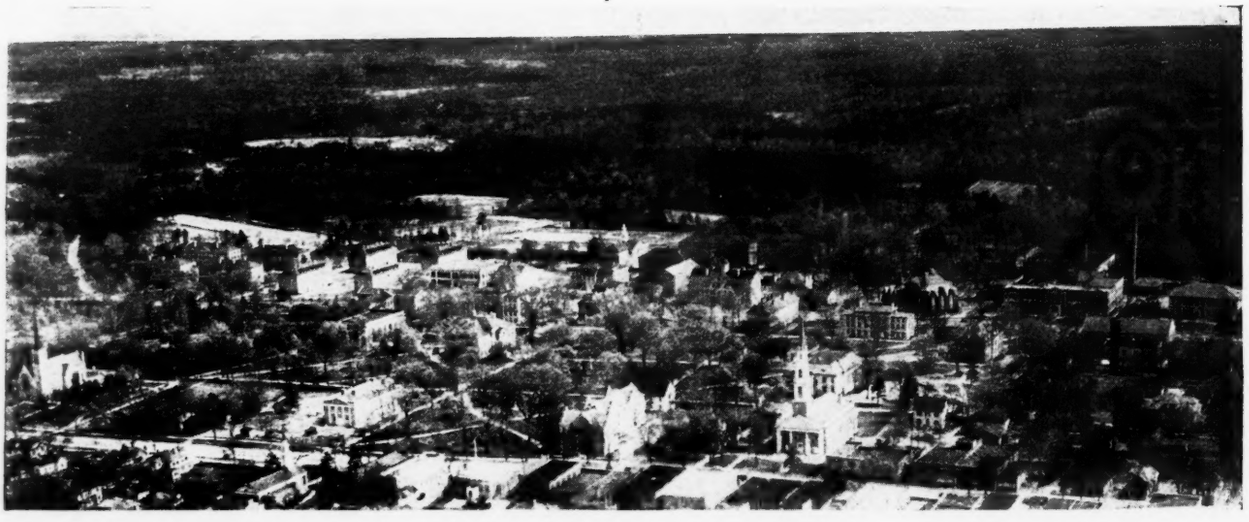
Power and Responsibility

NOTWITHSTANDING all that has been said about the efficiency of American industry, taken as a whole it is still inefficient. Anyone wishing proof of this need only start out blindly to find an efficiently operated manufacturing plant; unless luck is with him, the search may be long. True, some plants are operated intelligently, but they are the exception and not the rule. Even some of the larger establishments are examples of neglect and lack of good management.

But how can industry be efficient when there is such a lack of interest by management in the foundation on which industry is built? This foundation is power. Everyone grants that machines cannot produce unless a power supply is available to drive them, but it takes a failure of the supply to drive this fact home to some managers.

Until management is willing to take the responsibility of seeing that its power supply is efficiently obtained and applied, industry must be inefficient. The practice of paying the power engineer the lowest market rate and then forgetting him until something happens, has proved costly. This procedure involves not only an increased cost for power, but also losses due to improperly applied and maintained motors and power-transmitting equipment.

Management has tried too hard to forget the power problem, failing to see that power and economical manufacturing are inseparable. One of the supposed reasons for purchasing power instead of generating is that purchase relieves management of this responsibility. Whether power is generated or purchased, management must make certain that the man in charge of the plant's power operations knows how to get results, and must co-operate with him to that end. Sending a boy on a man's errand and then forgetting the boy, is not going to do the job.



Campus of the University of North Carolina

COMBINING HEAT AND POWER *in a Southern University*

BY I. W. SUMMERLIN
Consulting Engineer, Chapel Hill, N. C.

FROM 1795 to 1858 the few buildings that then formed the campus of the University of North Carolina were heated only by the open fireplace. This method of heating, so much used in the early days, has long since been abandoned and today, the campus, comprising 40 buildings, is heated by hot water and served with electric energy from a central power plant.

The first small electric plant was built in the late eighteen hundreds and contained two 35-hp. Erie engines with generators, one 800-sq.ft. fire-tube boiler and feed traps. In 1901 the capacity of the plant was doubled by the addition of two 30-kw. Ball engines and generators and two 1,000-sq.ft. h.r.t. boilers. Also, at this time the first central heating was attempted and thirteen buildings were included in the hot-water heating system. By 1916 the University had outgrown the capacity of the plant, and upon the recommendations of the engineers then acting as consultants, a new plant was built at the present site and the old one was entirely abandoned.

Minor changes and additions were made until in 1926 it again became evident that an engineering survey of the plant was necessary in order to increase its capacity to take care of present and future needs and to improve its efficiency to correspond with modern practice. At this time the plant contained the following major equipment:

Two 1,625-sq.ft. B. & W. water tube boilers.
One 3,500-sq.ft. Union boiler.
One 3,750-sq.ft. B. & W. boiler.
One 200-kw. turbine generator.
Two duplex boiler-feed pumps.
One open feed-water heater.
One 1,600-g.p.m. and one 2,600-g.p.m. hot-water circulating pump for the heating system.
One 2,600-g.p.m. and one 1,600-g.p.m. high-pressure heater for heating system.
One 1,000-g.p.m. low-pressure heater for heating system.

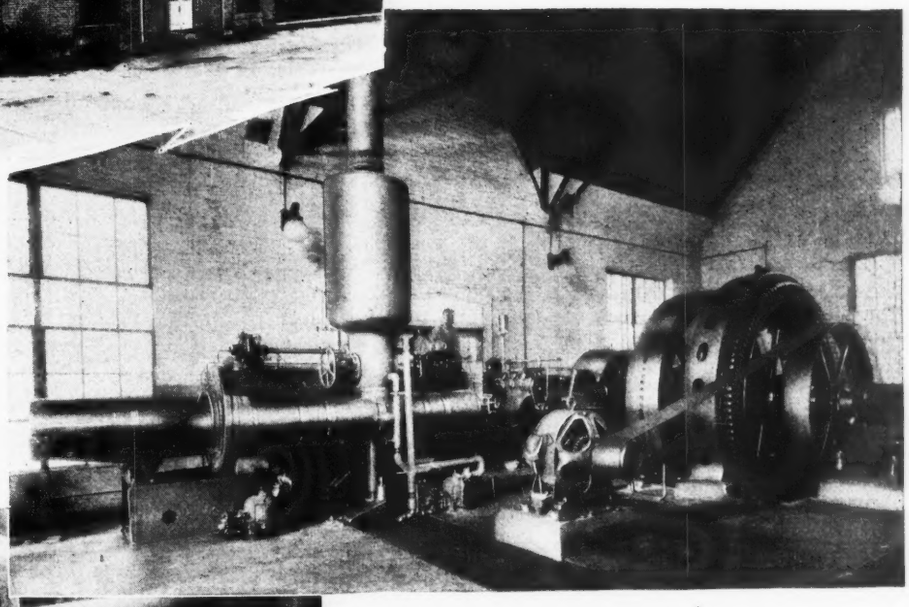
The boiler capacity, which totaled 10,500 sq.ft. of heating surface, was taxed to the limit during extreme weather and operated at an average efficiency of 57 per cent. The 200-kw. generator was too small to serve as an emergency unit in case of interruption to the central-station service.

The two small boilers and the Union boilers are served by a 60-in. diameter stack 100 ft. high, while the 3,750-sq.ft. boiler is connected to an 84-in. diameter 150-ft. stack. The small stack is just large enough to serve the boilers connected to it, and because of this stack limitation it was not practical to increase their capacity.

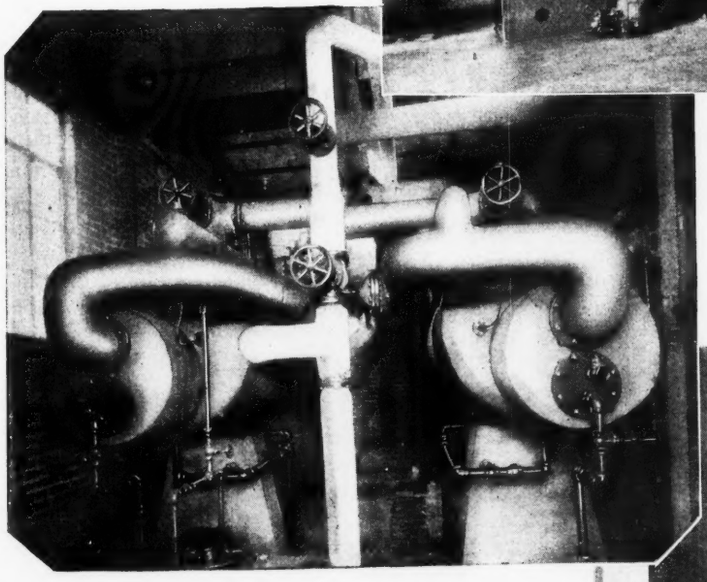
The capacity of the 3,750-sq.ft. B. & W. boiler could be increased sufficiently by changing over from hand firing to stoker. However, it was not advisable to increase the capacity of this boiler without making a duplicate installation, as the reserve capacity of the other boilers would not be sufficient in case it were out of service.

Accordingly, a new 3,890-sq.ft. Stirling boiler was installed, and stokers were provided for both it and the old 3,750-sq.ft. boiler. Combustion Engineering Corporation type E stokers were installed because they required a minimum of alterations to the setting of the old boiler, and the cost of installing a tunnel under the

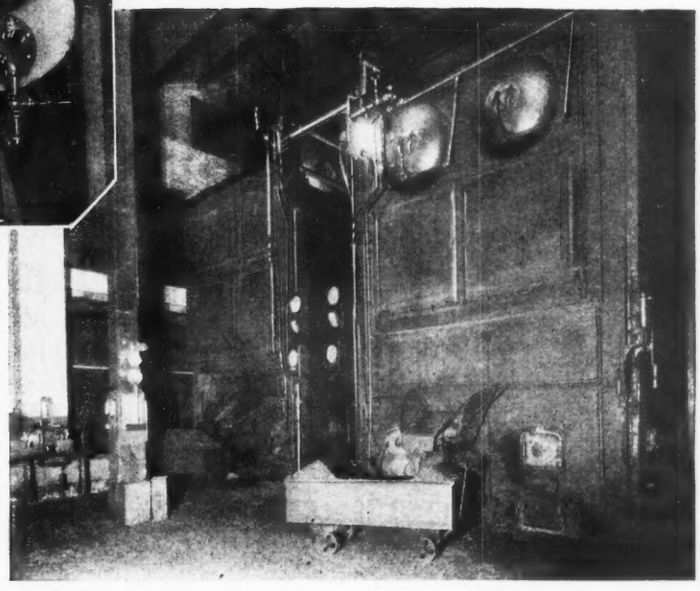
Central Power and Heating Plant University of North Carolina



Electric energy is furnished to the University and the town of Chapel Hill by this 600-kw. uniflow engine-generator set



Exhaust steam from the uniflow engine is used in these heaters to heat water for building heating purposes



A view of the boiler room showing how coal was handled before bunkers and the coal-conveying system were installed

boiler room for removing ashes from a rear-dump type stoker was in excess of the funds available.

Both the stokers and the turbine-driven blowers, which are of 16,500 c.f.m. capacity at 4½-in. static pressure, are regulated by step compensated regulators. Exhaust steam from the turbo-blowers is used in the feed-water heaters.

Coal Storage and Handling System Installed

In order to add to the cleanliness of the plant, to reduce costs and conserve man-power, a coal storage and handling system was installed to serve the two stoker-fired boilers.

Coal storage is under a trestle 30 ft. from the boiler room. A screw conveyor was placed beneath the storage pile from the trestle to the boiler room, and covered with removable steel plates. As coal is used, the steel plates are removed progressively from boiler-room wall toward the trestle. A portable belt conveyor fifteen feet long is used to convey coal from storage to the screw conveyor. The portable conveyor eliminates the wheeling of coal, shoveling directly from pile onto the conveyor as it is moved to a new source of supply being all that is necessary.

The screw conveyor delivers to a bucket elevator at the boiler-room wall, which in turn feeds to a screw conveyor over the boiler bunkers, each of five tons capacity. As the bunkers are filled progressively from the elevator end of the conveyor, the coal automatically seals the outlet in the conveyor bottom and coal is conveyed to the next bin. The coal-handling equipment has a designed

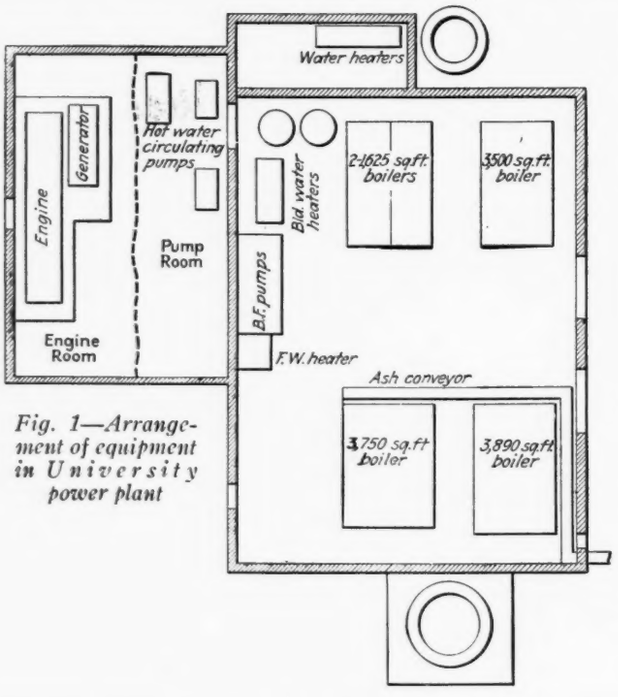


Fig. 1—Arrangement of equipment in University power plant

capacity of 23 tons an hour, sufficient for supplying all anticipated needs of the future.

For handling the ashes and soot from the two stoker-fired boilers an eight-inch steam-jet ash conveyor and a four-inch steam-jet soot conveyor were installed. Ashes are raked from the ashpits directly into the conveyor in front of the boilers and are discharged into a cast-iron target box, from which they fall into storage space on the ground.

Under present operating conditions, when 25 tons of coal is burned per day of eighteen hours, ashes are removed twice each nine-hour shift. The cost of steam for ash removal is estimated at 25 cents a ton of ash. Under actual operating conditions the conveyor handles ash at the rate of 100 lb. a minute.

In the past the University had purchased electric energy from the Southern Power Company, which it distributed to the campus and the town of Chapel Hill. The energy was paid for at the average rate of 1.47c. a kilowatt-hour. The total amount purchased was approximately two million kilowatt-hours a year at a cost

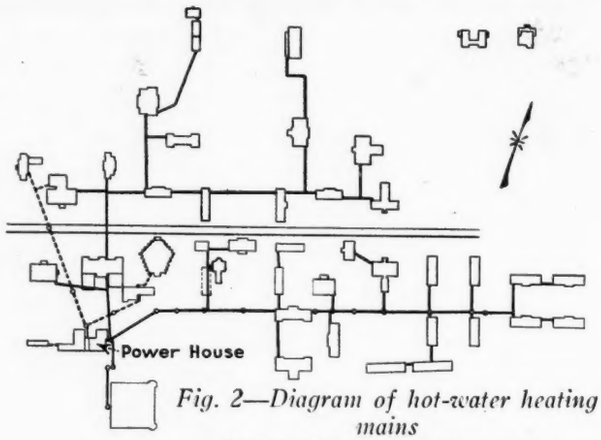


Fig. 2—Diagram of hot-water heating mains
Dotted lines indicate steam mains

of about $30,000. The daily load varied from about 140 to 500 kw., with a peak load of 600 kilowatts.

In planning the development of its own electric plant, the University considered the purchase of a 600-kw. uniflow engine generator set, a turbine generator set and continued purchase of power from the public utility.

A study of the situation indicated that considerable saving could be obtained by installing a generating unit and using the exhaust at two pounds back pressure to heat the water for the building heating system.

It was found that the guaranteed steam rate of the uniflow engine was about 30 per cent less than that of the turbines when back-pressure operation was considered. For this reason, and because the engine manufacturer proposed a savings purchase plan whereby the initial payment for the engine was one dollar, the remainder to be paid out of the yearly savings over the previous cost of power, the 600-kw. uniflow engine was decided upon.

Savings as Shown by Operation Tests

Approximately three months after the engine had been in operation tests were made in accordance with the A.S.M.E. test codes and showed that saving in excess of that anticipated under the guarantees was being obtained. It had been estimated that the saving by the operation of the plant over the cost of purchasing current at an average of 1.47c. a kilowatt-hour would be approximately $11,200 a year. The tests indicated this saving to be nearer $14,304 a year. Were this capitalized on a 20 per cent basis, it would permit an expenditure of approximately twice the actual cost of the installation.

Forty buildings are now connected to the central hot-water heating system. These buildings contain a total of 212,730 sq.ft. of equivalent hot-water radiation in both pipe coils and cast iron radiators. An average of 0.023 sq.ft. of radiation per cubic foot of building volume has been installed.

The underground heating mains consist of a supply and return pipe of the same size, run together in a con-

crete trench or terra cotta conduit. Two trunk lines supply all buildings connected to the system. Branch lines run from these trunks through the basement of each building and from these supply and return risers are taken to floors above. A valve is placed in the supply line to each building for regulating the flow, thermometer wells being installed in the supply and return pipe for use in determining the temperature drop in each building.

Circulation in the risers and through the radiators is induced by gravity, while circulation in the main is maintained by centrifugal pumps located in the power plant. The water is forced through heaters that are supplied with exhaust steam from the uniflow engine.

During the coldest weather practically all of the exhaust steam is used in the heaters. An increasing amount of exhaust is lost to the atmosphere as the weather becomes milder.

The design of the hot-water heating system is based on carrying a mean temperature of 170 deg. F. in the radiators. Allowing a 20-deg. drop with outside temperature at 10 deg., an initial temperature of 180 deg. is required.

The mains and branches to the North Campus consist of standard-weight pipe welded throughout, and expansion bends are utilized to take care of movements due to temperaure changes.. The ends of the pipe trenches, or conduits, are sealed to prevent air movement, dead air being considered a good heat insulator. Manholes were not provided, as pipe maintenance is not anticipated. The mains in the South Campus are also welded except where slip expansion joints are used.

Installation and Care of Valves

MUCH has been written concerning the selection of the proper valves. Each manufacturer has reasons why his particular valve should be purchased. On one point they all agree—that it is money well spent to purchase valves of dependable quality. It is economy to purchase them heavy enough to permit reseating over and over again. An inferior valve with not enough stock to permit its being repaired, is a costly installation.

First of all, use care in the installation of your valves. It pays well, for oftentimes trouble can be traced to careless installation. Examine each valve carefully before you put it in the line and see that all foreign matter is removed.

Be careful not to cut pipe threads too long because it permits the pipe to run up against the seat and ruin it.

Apply the pipe compound to the end of the pipe and not in the female end of the valve. This avoids getting the compound into the valve where it would cause trouble. In screwing a valve to a pipe, apply the wrench on the end that is being screwed. If you attach the wrench to the other end, the valve is subject to distortion. The valve should be tightly closed when being installed. This keeps it rigid, avoiding strain, and it also keeps the dirt out.

When the pipe lines are long, see that there are hanger supports enough to keep them free from sag. If you fail to do this, the valve seat may spring and cause a leaky valve.

It is common practice to install globe and angle valves with the pressure under the disk, but the installation should depend upon the condition to which the valve is subject. If in doubt as to how any valve should be installed, write the manufacturer.

In tightening bolts on flanged-end valves, tighten each bolt, a little at a time—do not screw one up as tight as possible before touching the others. This also applies to bolted bonnets.

After they are installed, valves should be blown or flushed to remove any foreign substance that might be in the pipes or valves.

If by chance the valves are strained when being installed and a leak develops, reseating will probably correct the trouble.

After the valve is installed, what then? What care should it have? Valves are the most important items in any installation of piping, be it steam, water, air, oil or what not. A valve that is well taken care of will last for years. Inspect them regularly.

The handwheel of a valve is large enough to close the valve without extra leverage. If it seats improperly, do not spoil the valve by forcing it; reseat it if necessary.

Open valves on pressure lines gradually. If opened quickly, any condensation will cause water hammer and strain the lines and fittings.

When a valve begins to leak, reseat it. Do not wait until a large hole has been cut through the seat or disk. When it begins to leak, only a little need be cut off the seat and disk. If neglected, the seat may become so badly worn that there is not enough stock left to permit repair. If you have the regrinding types of valves and fail to regrind in time, you can reseat them.

LESS WASTE IN POWER TRANSMISSION

ELEVATOR ROPES are power-transmission equipment the same as a rope drive from a motor to its load. Both offer opportunities for losses which may be avoided by proper selection, installation and care of the ropes and their sheaves. In the next issue will appear the first of three articles on elevator ropes. These articles will deal with the kinds of wire rope used for elevator service, factors that affect rope life, and the proper installation and care of wire rope. Information essential to the intelligent selection of wire rope is brought together in a concise form for the first time in the January 15 article.

Duncan, Okla., Municipal Plant Produces Power Cheaply

. . . BECAUSE

By J. H. Bender
City Manager

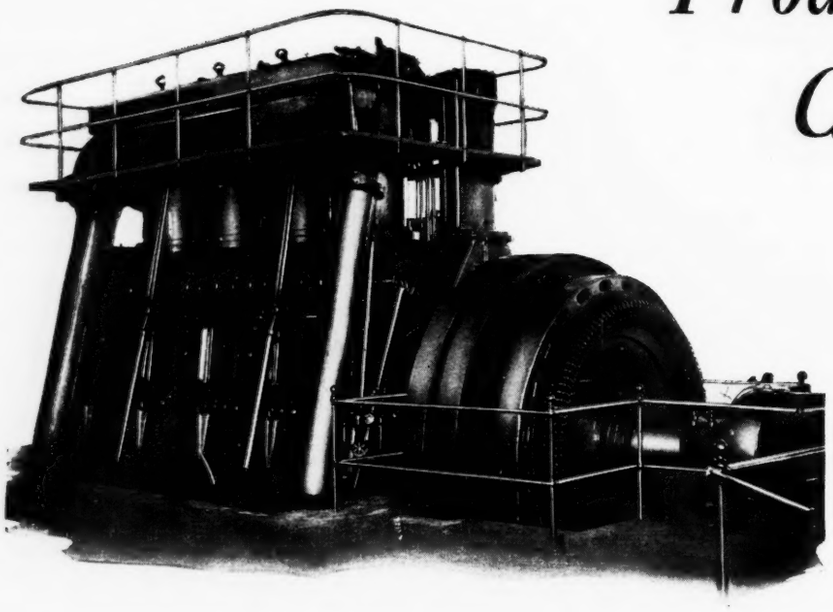


Fig. 1—665-hp. De La Vergne Diesel

THAT Duncan, Oklahoma, enjoys the lowest rates for electricity is made possible because the plant is powered by Diesel engines having a low-cost fuel and the operating force maintains the plant in a high state of efficiency.

Originally, all the electrical demand of the citizens was met by a privately owned plant, with the street lights carried by two 50-hp. vertical natural-gas engines belted through clutches to small generators in the municipal water works. The engines also drove the air compressors and the centrifugal pumps supplying water to the mains.

From this modest start the city plant's capacity increased with the remarkable growth of the town itself and part of the commercial lighting was carried by the city plant. In 1918 two 160-hp. Foos natural-gas engines, each direct connected to 125-kw. 2,300-volt 60-cycle three-phase alternators with belted exciters, were installed in an addition to the old plant building. By 1920 the plant was again badly overloaded and plans were made for a still larger plant.

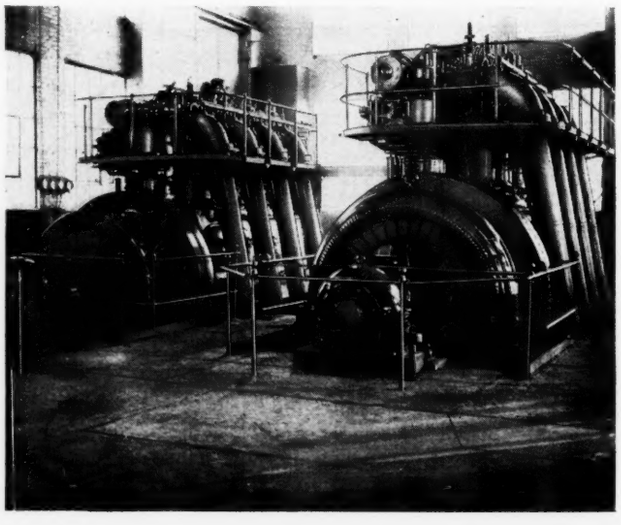
Because of the excessive rates charged the municipal plant for natural gas and the indifferent gas service furnished, it was necessary for the city to change to some other fuel. After careful investigation of the relative merits of steam, using oil or coal for fuel, and Diesel engines, the latter were selected for the 1921 extension to the plant.

At this time the city was growing rapidly, and to provide for the apparent needs of the future as well as the present, two Busch-Sulzer units were purchased. One was a 365-hp. engine direct-connected to a General Electric 250-kw. alternator with direct-connected exciter. This unit had four cylinders 16-in. bore by 24-in. stroke and turned at 225 r.p.m. The other, a four-cylinder unit 19-in. bore by 29-in. stroke was rated at 520 hp. at 200 r.p.m. and was direct connected to a 350-kw. alternator with direct-connected exciter. These two units were installed adjacent to the two Foos natural-gas engines, and a new building 56x80-ft., spanned by a five-ton traveling crane, was erected to house the enlarged plant.

An exceptionally complete switchboard, shown in Fig. 3, was installed, consisting of four generator panels, four exciter panels, one voltage-regulator panel, one totalizing meter panel, six distribution panels and two street-lighting panels.

Each generator panel has three ammeters, a watt-hour meter and an indicating wattmeter; each exciter panel has

Fig. 2—The two Busch-Sulzer engines



the usual voltmeter, ammeter and rheostat. The totalizing metering panel has a watt-hour meter, a recording voltmeter, recording wattmeter, indicating wattmeter, power-factor meter and a frequency meter. Three of the distribution panels are equipped with three ammeters, a watt-hour meter and an indicating wattmeter each, and the remaining three distribution panels and the street lighting panels have one ammeter and one watt-hour meter each. All outgoing circuits leave the switchboard

1. Diesel engines of modern design are used
2. A high-grade fuel oil is available at a low price
3. The machinery is kept in good condition at all times
4. The city does not interfere with the plant management

under the floor in lead-covered cables run in metal conduit.

This Diesel plant met the demands for power with some little help from the natural-gas engines until 1925, when a 665-hp. De La Vergne Diesel direct connected to a 450-kva. alternator with direct-connected exciter was installed in the same plant with the two older Diesels. Space for this unit in the old building was obtained by dismantling and removing the two 160-hp. gas engines, both of which have since been sold.

Cooling water for the three engines is supplied by two motor-driven pumping sets, one set consisting of a 15-hp. motor direct connected to two centrifugal pumps. One pump takes water from a 40x60-ft. spray pond and delivers it under 20-lb. pressure to the cooling-water header in the plant, and the other pump takes the warm water discharged from the engine jackets and delivers it through spray nozzles to the spray pond. One unit consists of two 3-in. Morris Machine Works pumps and a 15-hp. motor; the other is made up of two 2-in. Morris pumps direct connected to a 10-hp. motor, giving a maximum cooling-water capacity of about 300 gal. per min. This is barely sufficient to cool the engines under the maximum plant load of 600 to 650 kw. in hot weather, and additional pumping and spray capacity will be necessary with any appreciable increase of load. Normally, the temperature of the cooling water in the spray pond can be kept some ten degrees below atmospheric temperature, but often the water enters the engine jackets at temperatures above 90 deg. F.

As an emergency supply, water from the city mains under 50-lb. pressure is piped to the cooling header through a 3-in. Foster pressure-regulating valve set to open automatically if the pressure in the header falls below 12 lb. and to close upon re-establishment of the pump pressure.

Cooling-water makeup for the spray pond is softened in a Graver Zeolite softener with a capacity of 50 gal. per min. The raw water is very bad, containing about three pounds of incrusting solids per thousand gallons. With careful operation of the Zeolite softener the water goes to the spray pond practically without scale-forming impurities. However, we find this softened water soon absorbs hardness from some source, and we are now using a chemical furnished by the Metropolitan Refining Company, of New York, and sold under the trade name of "Duboth," in an attempt to prevent scale deposits in the engine jackets and excessive corrosion of piping. We have not used this treatment long enough to pass an opinion as to its effectiveness. For a short time the Zeolite softener was discontinued and the chemical treatment alone used, but without satisfactory results.

Fuel oil is unloaded by gravity from tank cars on the private unloading spur into a 42,000-gal. underground concrete storage tank near the building. From this underground storage fuel is pumped to a small service tank inside the building elevated above the fuel pumps of all the engines, from which it flows by gravity to the engine fuel pumps. An automatic float switch controls the motor-driven plunger pump lifting fuel from the underground storage to the inside service tank.

For some months past, 32-36 Baumé gas oil has been used for fuel. This is obtained from local refineries, and in the past year has never exceeded $1.46 per 42-gal. barrel delivered in the storage tank. A much heavier fuel could be used, but the difference in cost is only a few

Fig. 3—The switchboard is very complete

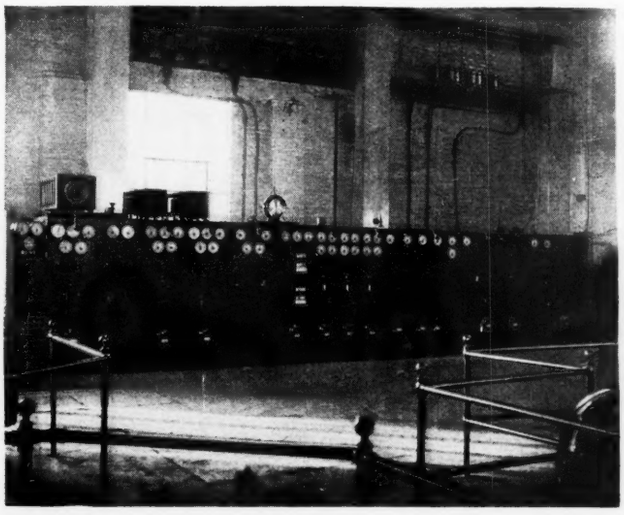
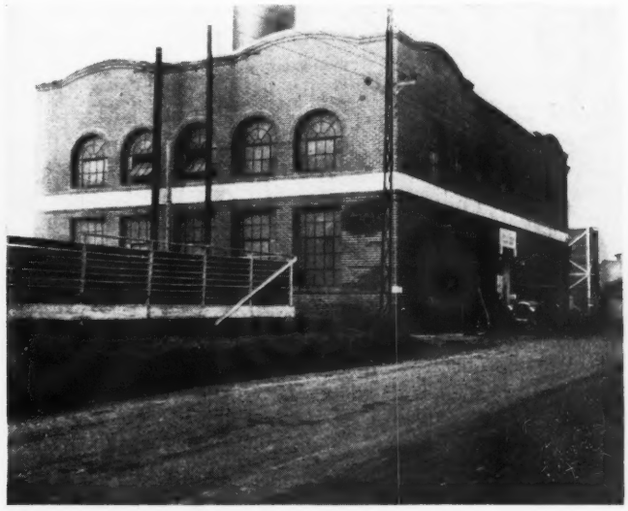


Fig. 4—The building and spray pond



cents a barrel and the gas oil makes an ideal fuel for Diesel engines. I believe the slight additional cost of this oil over heavier fuel is more than returned in reduced maintenance and repair expense.

A highly refined lubricating oil, manufactured from a mid-Continental paraffin-base crude is used in all three engines. This oil has a viscosity at 100 deg. F. of about 600 and at 210 deg. of 64 and is quite satisfactory.

Neither fuel-oil nor lubricating-oil centrifuges are in use. Used lubricating oil is taken from the engine crankcases and used in other municipal departments for street-maintenance equipment and for the water pumps of the water department, for which this oil is satisfactory after heating and settling out the heavier impurities. No exhaust pyrometers are used on any of the three engines, but we expect to purchase these instruments soon.

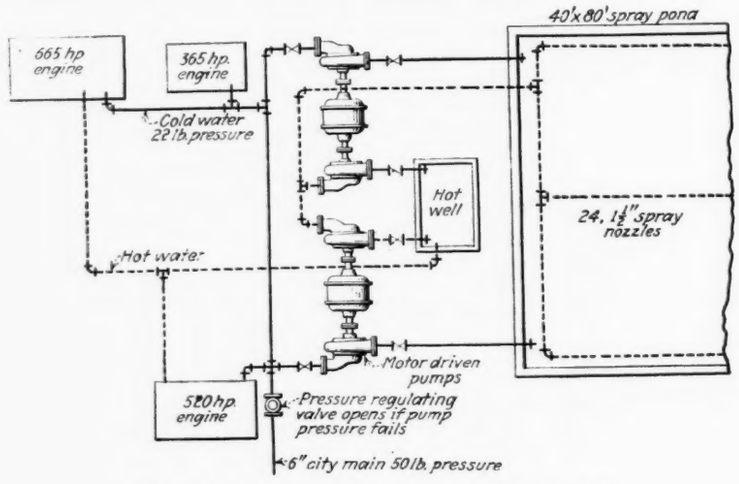


Fig. 5—Layout of the water-cooling system

The De La Vergne unit is equipped with a Reed air filter and takes its air from outside the plant building. The Busch-Sulzer engines take air from inside the building and are not now equipped with air filters. The results obtained from the air filter on the De La Vergne unit have been so satisfactory that similar filters will soon be purchased for the other engines.

The only auxiliary air compressor in the plant is a 3½x4-in. Type 15 Ingersoll-Rand belted to a 5-hp. 220-volt single-phase 60-cycle Century motor. This is used for charging the starting-air tanks for the De La Vergne unit, which requires starting air at 150 to 180 lb. The air tanks of the two Busch-Sulzer units are interconnected so that in case of loss of air for either unit the tanks may be recharged from the compressor of the other engine.

The two Busch-Sulzer engines have been in service since 1921, and with the exception of one cylinder on the 500-hp. unit, which was damaged by a broken crank-end bolt several years ago, no new liners or pistons have ever been purchased, and the original liners and pistons, barring accident, will still give several years' additional service. The De La Vergne unit has been in service about three years, and its cylinder, piston and bearing wear has not been excessive.

The Duncan plant is one of the few municipal electric systems operated in direct competition with a private electric utility. About ten years ago the private company constructed a high-voltage transmission line from Lawton, Oklahoma, 30 miles distant, where a modern generating station is operated. Since that time the Duncan plant has been dismantled, the building converted to an ice plant and the Duncan load served over the 33-kv. transmission line. The business in Duncan is probably about equally divided between the municipal system and the "high-line" system.

Because of this competitive condition electric rates in Duncan are lower than in any other city of comparable size in southern Oklahoma. By reason of these favorable electric rates it is conservatively estimated that the citizens of Duncan collectively are saving from $20,000 to $25,000 annually in their electric-service bills, over what they would have to pay under the established rates in other cities of similar size where such competition does not exist.

The service maintained by the municipal system is second to none, and in spite of the competitive condition, reasonably friendly relations are maintained with the high-line company, as is evidenced by the fact that three times in a recent period of three months, the city plant carried the Duncan load of the high-line company during the night, following interruptions of its service during storms. No doubt the high-line company would reciprocate should an accident of any nature to the city plant make assistance necessary.

In examining the report of the 1927-28 fiscal year's operation of the Duncan municipal electric system, shown in the table, it should be kept in mind that there are several unusual conditions which work to the disadvantage of the plant. The business is about equally divided between the two competing systems, with the result that the city has an abnormal investment in distribution lines, with an attendant high overhead expense. On account of a great many double-throw switches installed in the business district of the city, it occasionally happens that when the service of the competing company fails, the load on the city plant will increase 75 to 125 kw. in two or three minutes.

REPORT FOR THE FISCAL YEAR 1927-1928 OF THE MUNICIPAL ELECTRIC DEPARTMENT OF THE CITY OF DUNCAN, OKLAHOMA

Total power plant output, kw.-hr.	2,096,300
Used by water department (power for pumping), kw.-hr.	787,300
Used for public buildings, parks, etc., kw.-hr.	28,800
Used for street lighting, kw.-hr.	125,300
Used for unmetered street and alley lights, kw.-hr.	4,200
Total used by various municipal departments, kw.-hr.	245,650
Net output for commercial service, kw.-hr.	1,150,700
Gross income from electric-lighting service	$38,749.37
Gross income from electric-power service	9,553.93
Miscellaneous revenue	108.50
Value of power furnished water department, 787,300 kw.-hr. @ 2c.	15,746.00
Value of electric service for street lighting and other municipal purposes, 158,300 kw.-hr. @ 2½c.	3,957.30
Total gross revenue and value of service furnished to various municipal departments	$68,115.30
Operating and Maintenance Expense of Power Plants	
Salaries and labor	$6,788.36
Maintenance of power plant equipment	1,742.69
Fuel and lubricating oil	9,085.64
Miscellaneous expense	632.64
Total operation and maintenance expense	$18,228.88
Operation and Maintenance Expense, Distribution System	
Maintenance and lines and equipment	$3,205.89
Salaries and labor	3,578.00
Total	$6,783.89
General and Office Expense	
One-third total expense of City Clerk's Department	$1,989.29
One-third total Mayor and Commissioner's Department	2,012.36
Total general expense	$4,001.65
Capital Expense	
Interest 6 per cent on $314,393 outstanding indebtedness	$18,863.58
Sinking fund 5 per cent on $314,393 outstanding indebtedness	15,719.65
Total capital expense	$34,583.23
Total capital operating and maintenance expense	$63,597.65
Total cost per kw.-hr., cents	.03

Sand Used As Compressor
For a Refrigerating System

By John Cassiday

THE week beginning Dec. 7, 1928, was a hectic one in New York, with two engineering societies holding their winter meetings. As several sessions were going on simultaneously, one found it impossible to hear all the papers one believed to be of interest. Often one arrived too late.

That I found to be my problem, when I reached a session where a paper on the use of silica gel in a refrigerating system was to be discussed. The meeting had broken up and only a few engineers of the gossiping sort were left in the hall. Hailing an old friend, Rufus Beggs, I inquired as to what was new in his game.

"It looks," so Rufus snorted, "like a handful of pebbles will rob us engineers of our jobs running refrigerating plants."

"If times look that bad, I imagine a free lunch would have an appeal. Suppose we find a place where a dollar will buy a lot of food, and I'll buy and you can unload your woe."

Rufus never fails to accept an invitation, so soon we were both consuming oysters, while between bites Rufus explained about the pebbles.

In the past refrigeration has been produced by two systems; the absorption and the compression system. Now a third system appears—this is the adsorption system in which small particles of silica gel perform the service carried on by the compressor in the compression system.

Silica gel is a hard substance, resembling quartz sand; chemically, it is silicon dioxide, being made by the action of an acid on sodium silicate. The name "gel" is misleading, as in its final form it is not jelly like, although during the process of manufacture a jelly is produced.

The feature of this gel that has made it useful in the refrigerating field is that each particle contains a multitude of small pores, so small that they are invisible even under a microscope. These pores will draw in or adsorb any fluid in reach, and will disgorge the fluid if heat is applied.

An elementary system using silica gel is shown in Fig. 1. Suppose we place some of the gel in a sealed container *B* and to this container connect a set of evaporating coils *A*, containing liquid sulphur dioxide, or SO_2. As soon as the valve *V* is opened, the SO_2 will start evaporating and, flowing in *B*, is greedily devoured by the silica gel. This adsorption will continue until the gel has taken in 25 per cent of its weight of the sulphur dioxide. The process of adsorption by that time is practically completed. If, now, a lamp be placed under the container, the heating of the gel will drive off the SO_2, and if the valve *V* is closed and the valve *W* opened to pass the gas, the SO_2 will enter the condenser *E* and liquefy. The pressure at which the SO_2 is forced into the condenser depends, as in all systems, upon the effectiveness of the condenser.

From this elementary system the natural development is toward a system where the evaporation and condensation processes are continuous and automatic. This involves the use of two silica gel containers, suitable check valves and automatically operated burners. Such a system is outlined in Fig. 2. As shown, the container *B* is being heated and is discharging its SO_2 gas, and as the pressure rises, the suction check valve *X* closes by reason of the pressure difference and *U* is forced open to permit the gas to flow to the condenser. The evaporation going on in the evaporator creates enough pressure to lift valve *V* so that the suction gas enters container *A*, and of course valve *W* is held closed by the condenser pressure. The operation then becomes continuous, and automatic by the addition of a suitable burner control.

The burner control is set to cut off the heat before the container has emptied itself completely of the SO_2. The removal of the heat causes the container pressure to drop,

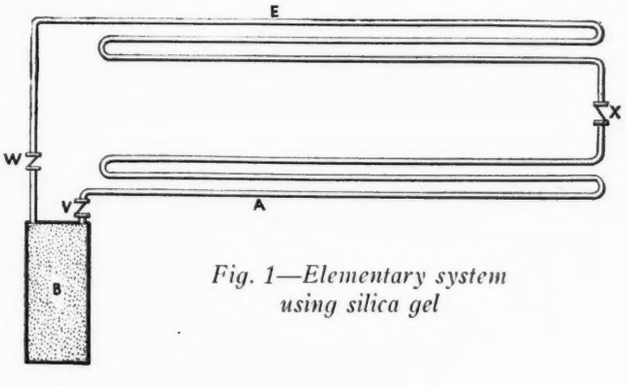


Fig. 1—Elementary system using silica gel

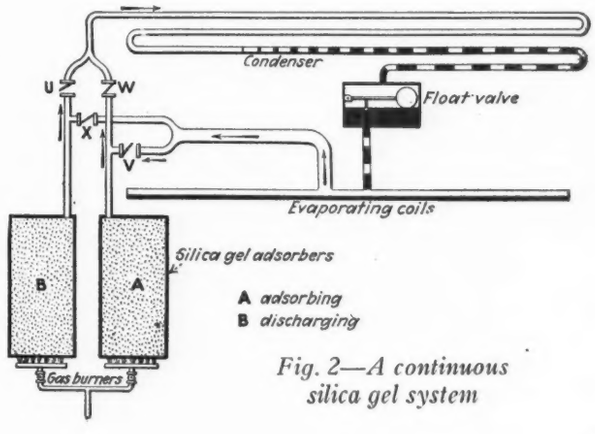


Fig. 2—A continuous silica gel system

and the discharge valve U closes. The flow of air along the container cools it off to the point where the pressure becomes less than that in the evaporating coils, whereupon the check W opens and container B starts its process of adsorption.

Cooling the gel container by air is slow, and consequently more time is consumed in cooling the gel than in the adsorption and expulsion of the refrigerant. As applied commercially, the burner is lighted for 35 minutes five times in 24 hours, although it is possible to have ten cycles per day. It has been found that each pound of gel will handle enough SO_2 to give 1 to 1.5 lb. of ice-making effect per 24 hours. The efficiency of the system is not high, as it requires a pound of fuel for each 15 lb. of refrigeration, or approximately 133 lb. per ton of refrigeration. With gas having a heat value of 20,000 B.t.u. per pound, this makes the efficiency of the system less than 10 per cent. This, however, does not compare unfavorably with household compression machines or with many steam-driven plants.

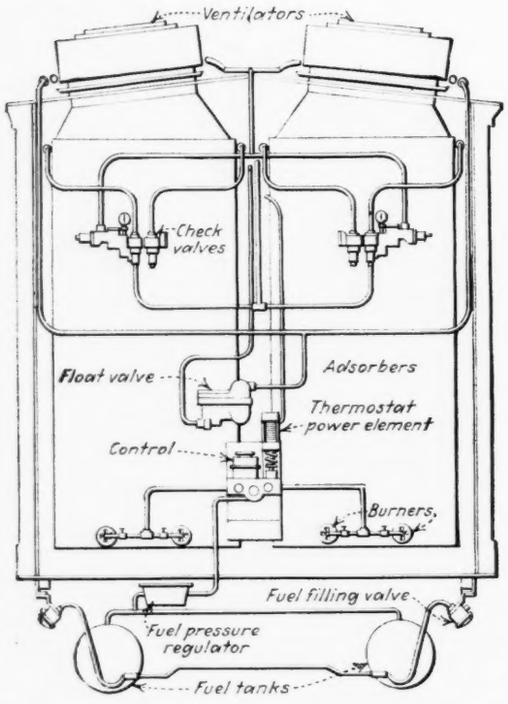


Fig. 3—The equipment in the end of the car

Silica gel has been employed in refrigerator-car work by the Safety Car Heating & Lighting Company. A cross-section of a car so equipped is shown in Fig. 4, while in Fig. 3 the car end is shown.

In this design there are two nests of vertical $\frac{3}{4}$-in. steel tubes with their lower ends sealed and the upper ends welded into headers. The nest holds approximately 1,000 lb. of silica gel. To have simultaneous adsorption and discharge, two such nests, or adsorbers, are used, each divided into two sections. These adsorbers are mounted in framework with the lower ends free to permit expansion and contraction. The framework is lined with heat insulation to form a flue for the gas burner placed beneath.

At the top of the assembly is an exhaust ventilator leading to the car roof.

Below each adsorber is placed a burner using propane. This under atmospheric conditions is a petroleum liquid and is carried in two holders beneath the car. On passing out of the holder, the liquid vaporizes, so that the burners handle a mixture of gas and air.

Normally, the apparatus operates on a fixed cycle in which the time intervals of adsorbing and discharging, as well as the idle periods, are of fixed duration. This is brought about by a control somewhat on the lines of a gas meter.

In order to control the temperature within the car, a thermometer bulb is placed inside with the power element at the control motor. The thermostat operates a small gas valve supplying gas to the timing device.

The condenser coils are placed on the roof of the car alongsidle the runway. A slat shield protects the coils from the direct rays of the sun. Experience indicates that when the car is idle the condensing effect of the coils is largely reduced, but there is at all times sufficient surface to prevent the pressure rising unduly. The operation of the silica gel is also influenced by the car's movement, for when idle the containers cool more slowly.

A number of these cars have been in the fish service between Boston and Texas. It has been found that temperatures below that obtainable with ice, can be carried and held uniformly. Of equal value is the avoidance of delays unusually occasioned by the need for re-icing en route.

A number of engineers claim that the silica gel system can and will be applied to commercial refrigerating plants, especially those of medium capacity in factories, small packing houses, and dairies. Its especial advantage is that it has no mechanical moving parts other than the control valve.

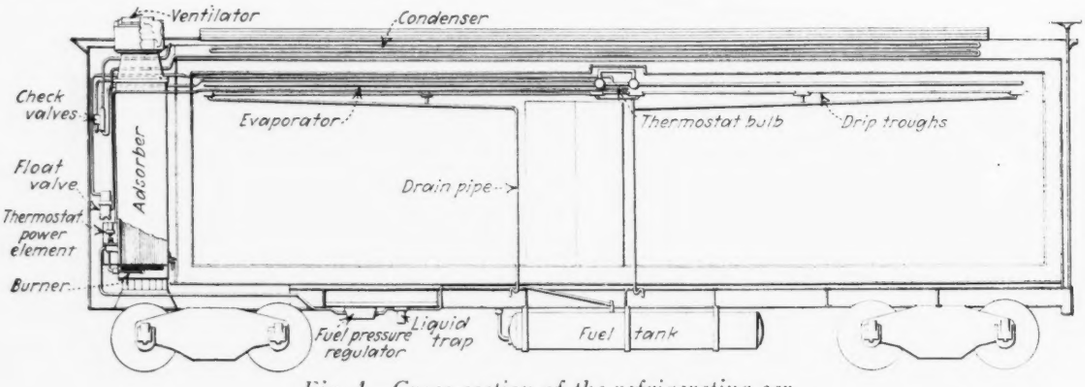
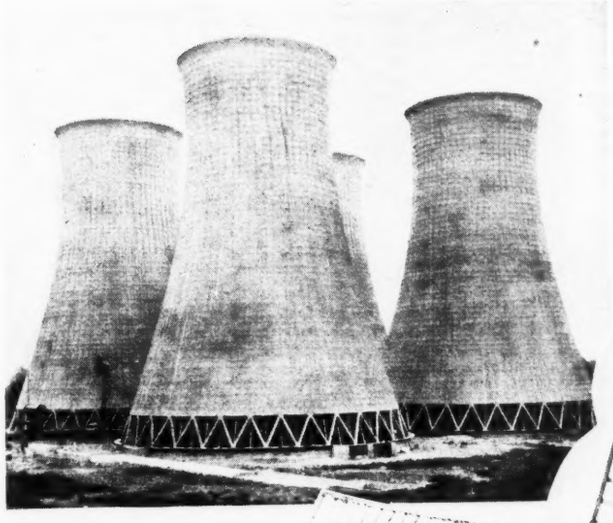


Fig. 4—Cross-section of the refrigerating car

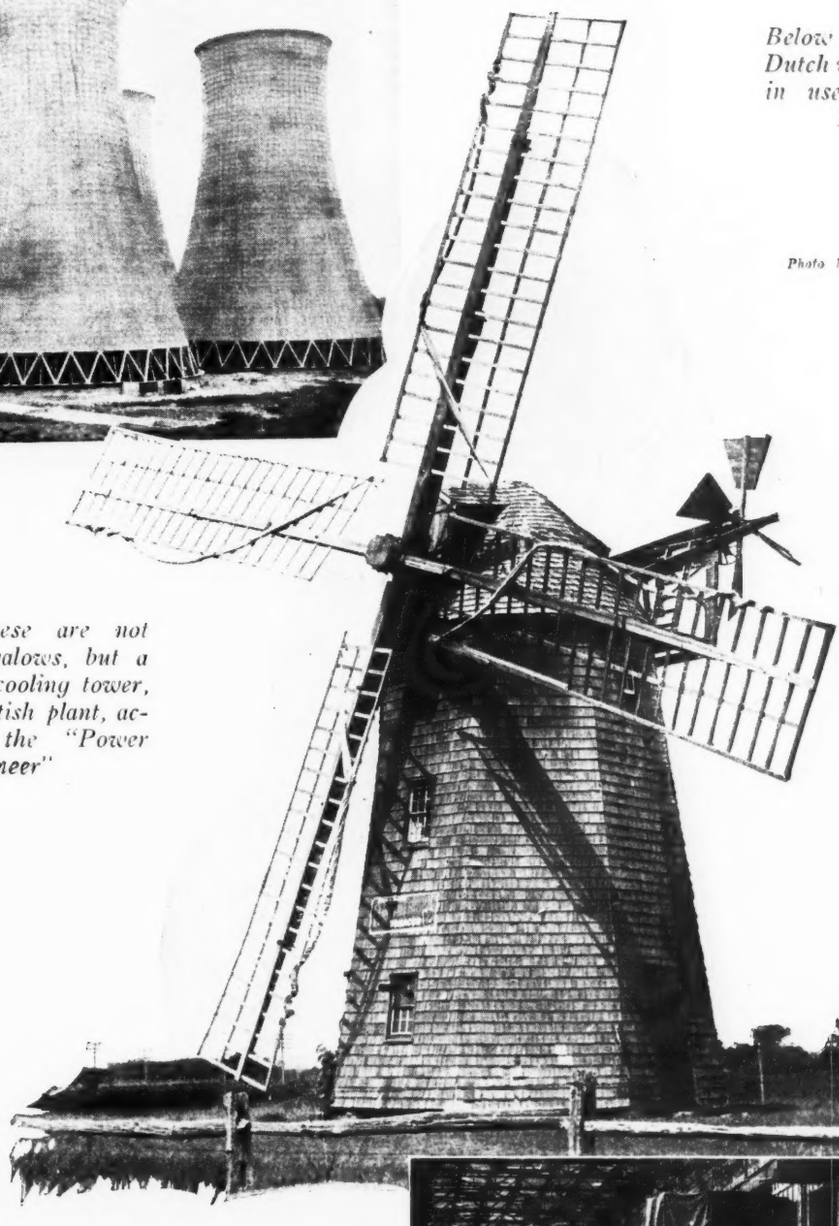
Steam, Wind and Water

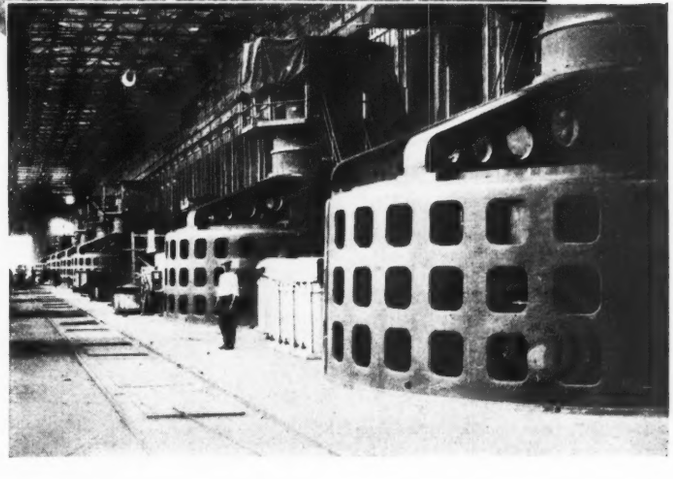


Above — These are not African bungalows, but a new type of cooling tower, used in a British plant, according to the "Power Engineer"

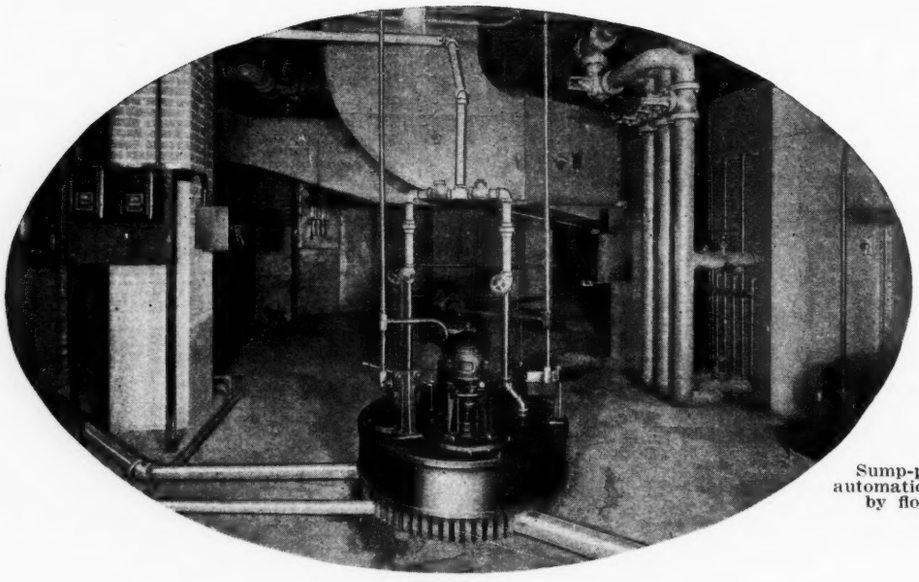
Below — An old Dutch windmill still in use in Rhode Island

Photo by Ewing Galloway





Right — Eight of the twelve 45,000-hp. hydro-electric units in the Isle Maligne plant of the Duke-Price Power Co., at Lake St. John on the Saguenay River, Quebec



Sump-pump motors automatically controlled by float switches

SELECTING CONTROLLERS

for Alternating-Current Motors

BY W. H. COSTELLO
Engineer, Cutler-Hammer Manufacturing Company

WHERE reduction in primary voltage is desired for starting polyphase squirrel-cage motors, starters using the principle of primary resistance are quite popular because of the advantages of economy and simplicity. There is also the advantage that, as the motor accelerates and the current decreases, the voltage across the resistance decreases and the voltage across the motor therefore increases, as also does the torque. For this reason the motor's rotor is nearer to synchronous speed before connecting to full voltage than with starters that maintain the starting voltage constant.

When auto-transformers are used to reduce the primary voltage for starting, the line current can be held appreciably below the current required by the motor. If the motor is connected to the 50 per cent taps of the transformers, the line current will be only a little more than half of the motor current. That is, if the motor current is 300 per cent of normal, the line current will be approximately 175 per cent of this value. In this respect auto-transformer starting is preferable to primary resistance. Not only are high starting currents avoided, but the power loss in the primary-resistor type starter is avoided. The auto-transformer starter, however, is more complicated than the primary-resistor type.

For single-phase commutator motors, starters and regulators are practically the same in construction as direct-current faceplate control. The power involved is small—about ten horsepower maximum. Larger single-phase motors are sometimes used, but are classed as special rather than standard.

A standard, inclosed-fuse knife switch can be used for starting squirrel-cage motors when full voltage can be applied, but low-voltage protection is not afforded and it is difficult to obtain reliable overload protection with fuses. When the starting load is heavy, the fuse capacity is frequently determined by the starting inrush rather than the normal load rating. To meet this requirement there is available an inclosed starting switch, using thermal cutouts which have a time delay.

Manual starters are also made with a step of resistance in the starting circuit and rated up to ten horsepower at 220 volts. They are considerably lower in price than the automatic primary-resistance starters and are used where local

Types of Controllers for Alternating-Current Motors

Squirrel Cage Motors

MANUAL	AUTOMATIC
Across-the-line	Across-the-line
Primary-resistor	Primary-resistor
Auto-transformer	Auto-transformer
Star Delta	

Slip-Ring Motors

Faceplate	Time-Limit
Multiple Switch	Series-Relay
Drum	

Synchronous Motors

About the same as for squirrel-cage motors, but with provisions to control the field circuit.

regulations require reduced-voltage starters where the horsepower exceeds five.

Auto-transformer controllers, commonly known as compensators, still remain the most extensively used type of starter for squirrel-cage motors up to 150 hp. at 550 volts and up to several hundred horsepower at 2,200 volts. It is standard practice to use oil-immersed contacts. The structure is always inclosed and low-voltage protection is an inherent feature. Several taps are provided on the transformer coils to give starting voltages from 50 to 80 per cent, but the 65 per cent taps are most generally used. In some plants automatic compensators are used exclusively, so that the motors will at all times be properly started.

Practically all commercial manual compensators are provided with overload protection. For some special applications overload and undervoltage protection is not required or desired, in which case the compensator must be held in the running position by a latch and released manually.

Multiple-Switch Starters

The standard use of alternating-current multiple-switch starters is for starting slip-ring motors, but they are sometimes used for squirrel-cage motors. The latter application is where local regulations definitely limit the current inrush per step but not the maximum starting current. The purpose of this regulation is to insure that the voltage regulators will have time to function and thereby prevent any noticeable fluctuations. Multiple-switch starters meet the requirements because the operation of the several switches introduces the necessary time element and the current inrush per step can be limited by resistor design. Multiple-switch starters are practically the same in construction for alternating current as for direct current, except that for the former two-pole switches are used.

For starting and for regulating the speed of small slip-ring motors face-plate controllers with resistors connected open-delta are extensively used. For motors of larger horsepowers star-connected resistors are used and the current in each leg of the rotor winding is balanced.

For simple starting and regulating functions the face-plate secondary controller is economical, but it has limitations that can be more easily taken care of by a drum controller. The faceplate starter can be equipped with no-voltage release so the lever will return to the starting position should the voltage fail. When this feature is supplied, the primary switch must be provided with low-voltage protection.

The majority of alternating-current drum controllers are used for starting and for regulating the speed of slip-ring motors and for multi-speed squirrel-cage motors. They are also used in some cases for full-voltage starting of squirrel-cage motors and for the star-delta method of starting.

For slip-ring motors the drum controller has the advantage over other forms of manual controllers in handling the primary circuit as well as the secondary. This is of particular importance in reversing service where a primary switch is required for reversing the primary connections. It has the mechanical advantages of substantial and simple construction, small space requirements, ease of operation and being totally inclosed.

Where low-voltage protection is required for slip-ring motors, a magnetic contactor for the primary circuit, properly interlocked with the drum controller, is used. The customary method of interlocking is to provide an auxiliary contact which makes it necessary to return the drum to the off position in order to close the control circuit of the primary switch.

For manual control of multi-speed squirrel-cage motors the drum controller is practically the only economical type of controller that can be used. The connection combinations for multi-speed motors are often quite complicated, and the inherent design of the drum controller qualifies it better than any other class of manual controller for this service.

Across-the-line Automatic Starter

The recognized standard automatic across-the-line starter consists of a three-pole magnetic switch, inclosed and provided with thermal overload relays. This type of switch is made for capacities up to several hundred amperes and is extensively used as a primary switch with drum and other forms of manual slip-ring motor control-

Fig. 1—Automatic controller for large synchronous motor in yeast plant

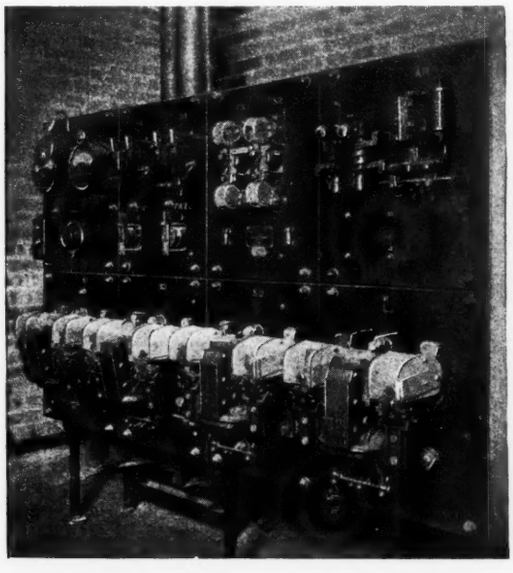
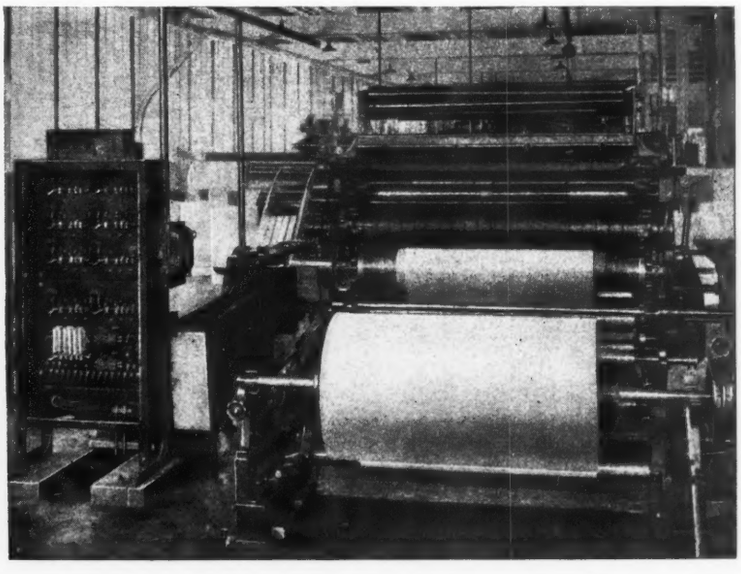


Fig. 2—Automatic controller for motor driving a color press in a waxed-paper plant



lers. Either no-voltage protection or low-voltage release is provided as desired.

Although the automatic primary resistor starter is somewhat higher in cost than the manual controller giving similar functions, it is widely used in preference to manual control because of the advantage of push-button starting and stopping. It is commonly used for the automatic starting of squirrel-cage motor driven pumps operated from pressure gages or float switches and similar service.

Automatic Compensators

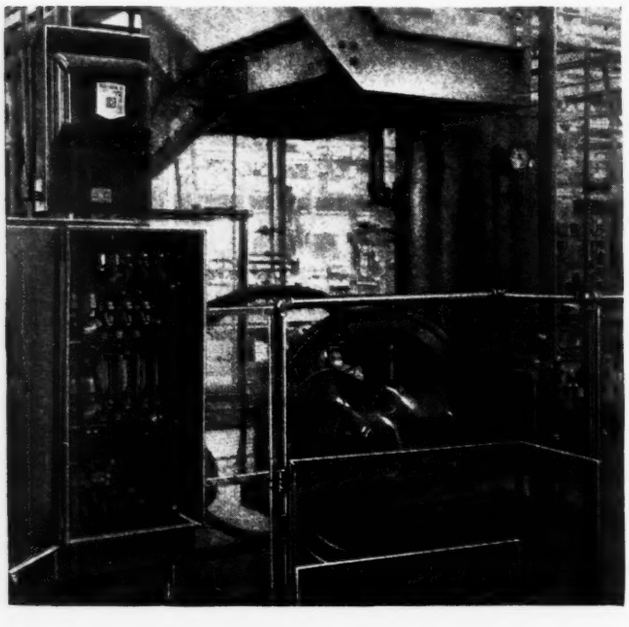
The automatic compensator panel is built much like the automatic primary resistor, except that a five-pole switch is used for starting and an auto-transformer replaces a step resistor. It is appreciably higher in price than the primary-resistor starter, but the higher cost is justified for installations where it is necessary to keep the starting current in the supply line as low as possible.

For 2,200-volt motors or higher, oil switches are used for starting and running, the timing mechanism is a separate solenoid-operated device and the magnet coils of the oil switches are energized through magnetic relays so that the push-button or other master switches handle only the current of the relay coils. For motors up to 125-hp. capacity the high-tension controller is made in a complete unit, but for larger horsepowers the transformers are usually supplied for separate mounting.

With slip-ring motors the automatic starter controls both the primary and secondary circuits and gives low-voltage protection or low-voltage release. The primary switch may be of the two-pole or three-pole type, while the accelerating contactors, for cutting out the secondary-circuit resistance, are nearly always two-pole.

Two types of controllers are offered: one, using the time-limit method of control, is standard, and the other, a current-limit method, is special. Where the load range is wide and the motor must be started under heavy loads, the time-limit acceleration method is more satisfactory. A centrifugal pump or other loads of similar characteristics come within the limitations of the time-limit con-

Fig. 3—Automatic starter on Fynn Weichsel motor driving an air compressor



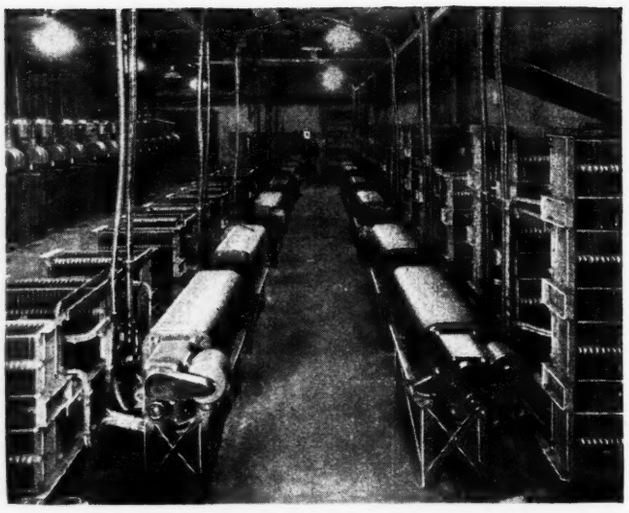


Fig. 4—Motor-driven drum controllers and secondary resistance for boiler draft-fan motors

troller. Both the open panel and inclosed are offered as standard. Below 100-hp. this controller is self-contained, but for larger ratings the secondary resistor is mounted separately. The current-limit type of controller is recommended for flywheel loads, such as punch presses and extractors.

The non-reversing controller is standard up to 200 hp., while reversing controllers are listed standard up to 30 hp. For larger motors the requirements are often somewhat special and the controllers are built to specifications. Overload protection is optional on these controllers, but in line with present tendencies overload relays will soon be a standard feature.

Where it is required to regulate the speed of a slip-ring motor from a remote point by push button, the secondary regulator is usually a motor-operated faceplate or drum controller. This is a semi-special type because the service conditions which require push-button regulation are quite infrequent.

Pressure controlled speed regulators are commonly used for draft fans, gas pressure and vacuum pumps. The control panel is of the faceplate type, and the regulator arm is operated by a cylinder or motor. The secondary regulator is interlocked with a primary switch to open the motor circuit in case the pressure becomes too high.

For multi-speed induction motors an automatic controller consists of a combination of three-pole switches properly interlocked, the number of contactors depending upon the number of speeds and complications of connection. Because of the variety of combinations required, this type of controller is usually made up to specifications.

The method of starting synchronous motors is about the same as for squirrel-cage motors up to about 90 per cent speed, after which the action of the direct-current field brings the rotor up to full synchronous speed. Special provision must be made for handling the field circuit during starting. The field being wound with a large number of turns has a high voltage induced in it by the rotating field of the primary winding. The most common method of protecting against breakdown is to short-circuit the field through a resistance when starting. Another method of obtaining this is to provide a field break-up switch to limit the voltage induced in any one section of the field.

Square Bends Reduce ELBOW LOSSES IN DUCTS

BY B. L. SPIVAK

Thomas E. Murray, Incorporated

IN HIS article on duct design, appearing in the Oct. 23 issue of *Power*, E. D. Edwards showed the superior efficiency of a square-cornered elbow as compared to the ordinary rounded one and a saving of 408,000 kw.-hr. of auxiliary energy resulting from its use. This novel departure need not be viewed with skepticism, as it is the result of the extension of known and accepted laws.

The purpose of an elbow in a duct is to change the direction of flow. To do this most efficiently, the bend should offer the least impedance, the major causes of which are turbulence, surface friction and restriction of flow area. Each of these factors reduces the available static pressure and therefore the work capacity of the

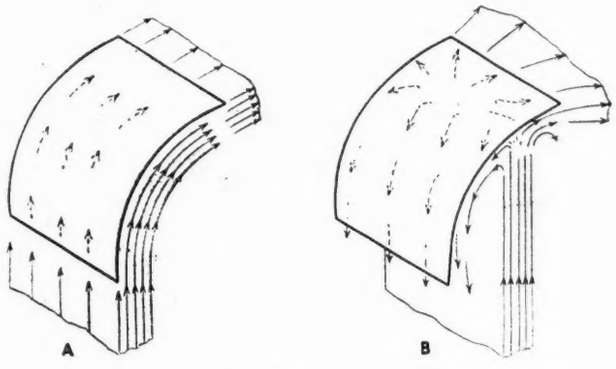


Fig. 1—What happens when an air jet impinges on a curved surface

air. By proper design of the bend, these dissipative conditions can be almost eleminated.

The jets *A* and *B* in Fig. 1, are both directed against similar curved surfaces. Jet *A* strikes the steeper portion of the curved surface and is changed in direction with practically no turbulence. Jet *B* strikes the flatter portion of the surface and breaks up into currents moving in all directions. Since the portion moving in the required direction is but a fraction of the original jet, this method of diverting flow is wasteful. It follows that a curved surface is the most efficient in diverting a jet when the direction of the jet at the point of impact is parallel to the tangent to the surface at that point. Surface friction is less in jet *B* than in jet *A* merely because the velocity of the induced currents, which are in contact with the curved surface, is lower than the velocity of the normal flowing air. Nevertheless, the energy loss due to turbulence and the scattering of the jet in all directions more than outweighs the reduction of surface friction.

Consider the flow of air in an ordinary elbow as shown in Fig. 2. The volume can be considered as made up of a number of contiguous jets of minute depth and of a width equal to that of the elbow. The jets nearer the outer curve change in direction with but little dis-

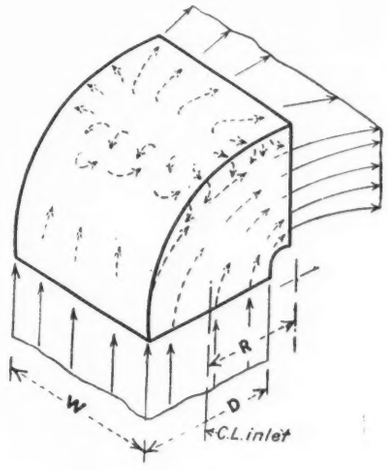


Fig. 2—Air currents set up in an ordinary elbow

turbance, but those nearer the inner curve, upon striking the stream near the top of the bend, create currents directed toward and against the flow and toward the sides

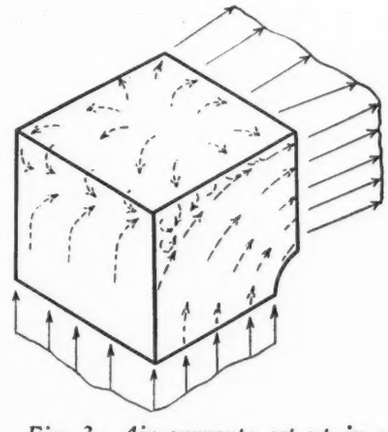


Fig. 3—Air currents set up in a square turn

of the duct. Of course, the effect is not so pronounced as in jet *B* since the normal air flowing assists in turning that portion of the air nearer the inner curve. The currents directed toward the sides, upon striking them, also

break up into component currents. The disturbances thus produced are concentrated in the upper portion and along the sides of the elbow. The effect of the air layer near the outer radius is to move the zone of turbulence nearer the elbow outlet. As a result, the area of flow is reduced and a serious loss introduced.

Fig. 3 shows the air distribution in a square elbow. There is a little more turbulence with this kind of bend than with an ordinary one, but the component currents moving against the normal flow reach the quiet zone immediately under the corner. The rest of the air stream sweeps by this zone, and since there is more area at this point, less of the flow area is affected. This improves the efficiency of the bend.

Dimensions of Bend Affect Efficiency

In general, the efficiency of bends depends upon the relation between the dimensions of depth D, width W, and radius R. The ratio W/D is known as the aspect ratio, and R/D as the radius ratio. Experiments have shown that bends of an aspect ratio of about four are best. With a duct width of four times the depth, the

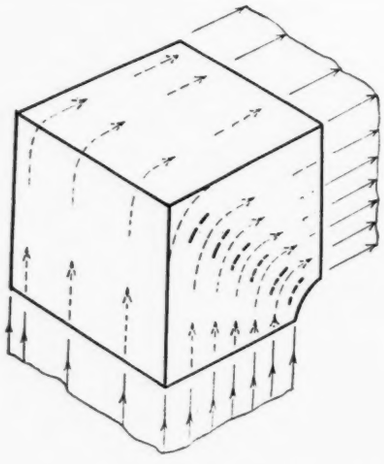


Fig. 4—Vanes in a square turn improve efficiency of the bend

currents moving toward the sides are for the greater part absorbed before they reach them. The turbulence near the sides affects a relatively smaller area of the flow, resulting in improved efficiency. With aspect ratios greater than four, the increased area of contact between air and duct increases the surface friction, while with aspect ratios of less than four, the disturbances at the sides penetrate farther into the flow area. Both conditions reduce the efficiency considerably. Also, for best results the bend should have a radius ratio of at least six. Then, practically the whole jet strikes the steeper portion of the curve and little turbulence results. From the foregoing it follows that a large radius bend of pronounced rectangular cross-section is best adapted to change the direction of flow. In a straight run of duct the greatest loss is occasioned by surface friction. Since a prism of square section has the lowest ratio of surface area to volume, this section has been generally adopted for straight runs. The extension of such a section to bends was due to the failure to analyze the nature of the losses involved in each case.

The large volumes handled by ducts, especially in forced- and induced-draft systems, and the restricted space available make it impossible to install bends of the form treated herein. But by adding blades in a square elbow, as shown in Fig. 4, any bend can be made to give the highest efficiency. An inspection will show that the elbow is really equivalent to a number of contiguous bends of high aspect and radius ratios. This results in a minimum turbulence and flow area reduction. The blade area is made small compared to the duct dimensions, so that surface friction is but slightly increased. This form of bend, therefore satisfies all conditions for highest efficiencies, and its application may reduce losses by as much as 80 per cent.

Anti-Friction Bearings Save Power in Steel Mills

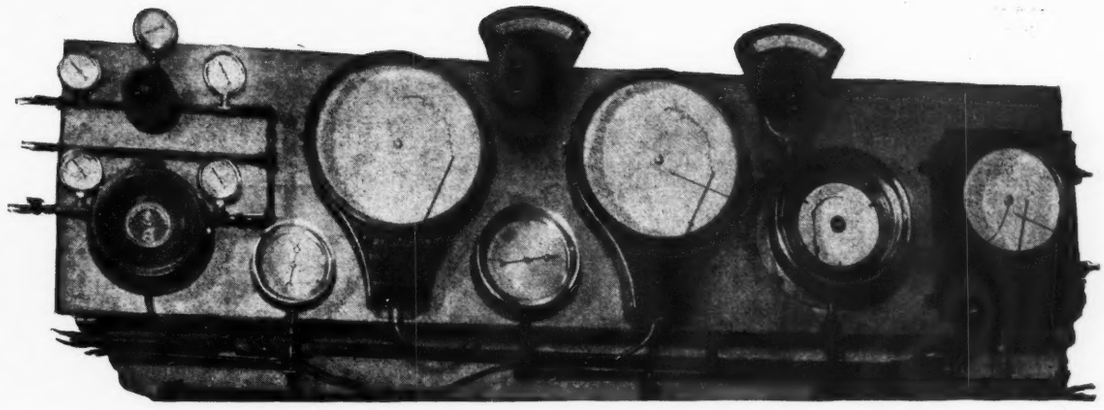
COMPARATIVE power consumption tests on mills run alternately with anti-friction bearings and plain bearings have yielded valuable data, according to a paper by Sidney G. Koon, given before the iron and steel division of the A.S.M.E. at their recent annual meeting in New York.

Variations in temperature of the steel being rolled have made the tests less directly comparable than might be wished, but the information available is being augmented from time to time by additional test data. The earliest, and possibly the most complete, of these tests were made on a three-high 16-in. bar mill at Canton, Ohio. Records of the rolling of 279 billets, in test made $2\frac{1}{2}$ years ago, showed average savings of about 48 per cent.

In another case a two-high 10-in. rod mill was tested both with plain bearings and with roller bearings. With plain bearings the power needed without load was 95 hp., increasing to 170 hp. while rolling steel. With roller bearings the mill load requirements was only 20 hp., and 95 hp. while rolling steel. Here the saving of 75 hp. represents 44 per cent of the previous full load of 170 horsepower.

THE EASIEST SAVING

With a steam pressure of 150 lb., each lineal foot of a bare 12-in. pipe will waste about one ton of coal per year in radiation, assuming that steam is in the pipe continually. The application of good pipe covering will save at least three-quarters of this, generally more. Economically speaking, it is nothing short of criminal negligence to leave steam pipes bare. Where such a pipe is used only at rare intervals, it may pay to install a stop valve to eliminate the radiation loss during periods when the pipe is not in use. Valves are naturally expensive for large sizes of pipe, yet a little calculation will show that the investment yields an excellent return even where the pipe is insulated.



Instrument and Control Board

Automatic Control Improves Product And Lowers Cost

in system supplying water for process at 300 deg. and 300 lb.

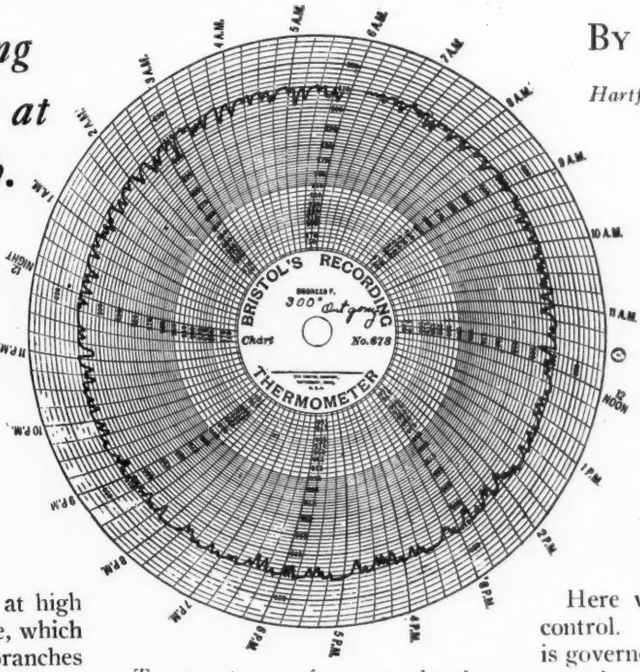
By H. S. Sturtevant

Plant Engineer, Hartford Rubber Works Company

THE rubber industry, in common with a number of other specialized industries, furnishes many examples of the application of power for a variety of uses. This particular application, in service at the Hartford plant of the United States Tire Company, is an interesting example of the use of water at high pressure and high temperature, which should be of interest to other branches of industry.

Improvements in processes, increased quality of product and the desirability of lowest possible costs have called for decreased vulcanizing time in the curing of automobile tires and the application of heat to the inside as well as the outside of the tire at the very start of the vulcanizing process. In times gone by heat was applied to the outside of the tire only, but changes in process and development work covering the betterment of the quality have shown the advantages of the double application.

The system that we are to describe is for the purpose of supplying the heat to the inside of the tire. Briefly, this is done by placing a heavy rubber bag in the tire before it is put into the curing mold, this bag being connected to the outside of the curing vulcanizer by a special manifold piping system.



Temperature of water leaving heaters ranges from 304 to 310 deg. Return temperatures, not shown, average about three degrees lower

The process water unit supplies hot water at 300 deg. F. and 300 lb. pressure to the manifold system. One of the most interesting features is the automatic control and alarm system, which enables the unit to operate at steady temperatures and pressures for 24 hours a day without the services of an operator in constant attendance.

The water is heated by three Ross water-tube heaters arranged in parallel and so piped that any one may be cut out of service in case of trouble. Steam is used as the heating medium and is supplied direct from the boilers at 140 lb. pressure.

Here we have the first automatic control. The flow of heating steam is governed by the temperature of the outgoing water leaving the heaters by a diaphragm valve in the main steam feed line and controlled by a thermostatic bulb in the water outlet line. In this way the flow of steam into the heaters is governed by the amount of heated water drawn out to the tire-curing system.

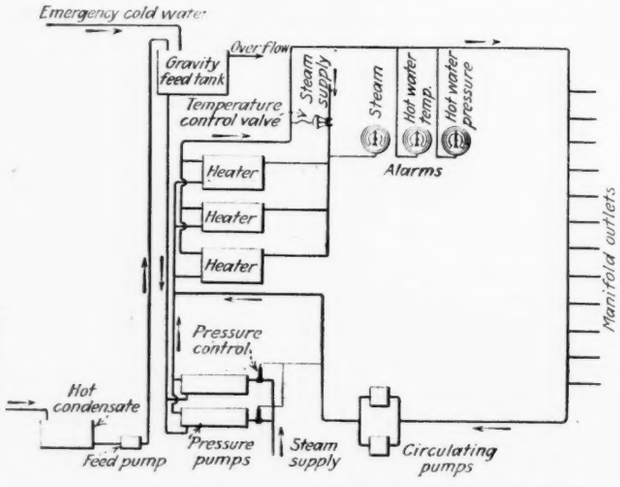
The heaters are heavily lagged with heat insulation, and the ends, which require occasional removal for tube cleaning, are covered with woven asbestos caps. On each heater an automatic steam trap of usual design controls the flow of condensation, which is returned to the boiler house. Any two of these heaters will carry the load, this factor of operat-

ing safety being held to throughout the unit, because of the importance of avoiding interruption in this service.

Hot-water pressure is maintained in the system by two Worthington duplex plunger pumps, steam operated. Speed of operation is controlled by pressure-operated steam throttle governors operating from the pressure in the hot-water line. Either pump is sufficient to carry the load, but keeping both on the line cuts down the service per pump and eliminates chances of shutdown from pump failure.

Constant Circulation Maintained

Because of the length of the line supplying the manifolds on the vulcanizers, it is necessary to keep the water in the system in constant circulation. The piping is so arranged that there is a complete circuit from the heaters through the manifold supply line and back to the heaters through a return line. This circulation is maintained by one of two motor-operated Manistee Roturbo single-stage centrifugal circulating pumps operating in the line



Circulating pumps carry pressures above 300 lb., but consume power corresponding to a pressure difference of about fifteen pounds

at 300 lb. pressure. These pumps maintain a positive additional pressure of about fifteen pounds which is sufficient for circulation.

The supply of water for the heaters comes from an open tank near the ceiling with a gravity feed. Water reaches this tank from two sources. The main supply is condensate from the vulcanizing presses, which is utilized in order to maintain maximum efficiency. This water is collected in an auxiliary tank located near the vulcanizers, and raised to the gravity-feed tank by a small electric pump. In this way water is supplied at 200 deg. or better.

The gravity tank is provided with an overflow pipe with direct connection to the sewer, since this water is not fit for use in the boilers. As an operating safeguard the city water service is connected to the gravity tank through a float valve which operates in case of a deficiency of hot water or failure of the hot-water supply pump.

It will be noted that, all the way through, every precaution in the way of duplicate units or double sources of supply has been taken. This is the usual thing in power-plant practice, and as this unit must function for 24-hour service 6½ days a week, the same precautions had to be taken here. In case of failure of the entire system a connection can be made instantly to a 300-lb. cold-water hydraulic line, but this has never been used. The vulcanizing time for a tire is something that must be controlled very accurately, and the use of the cold water in place of the usual supply calls for an adjustment of the time which is difficult to make. That is why such great precautions have been taken to insure uninterrupted service.

Referring to the diagram, the flow of water can easily be followed. It goes first from the open tank to the duplex pressure pumps. Then it enters the main lines on the way to the heaters, the direction of flow being controlled by the circulating pumps. Leaving these heaters, it passes to the main supply line. After passing through these, the unused water returns to be reheated and recirculated.

Water System Under Power Department

Of necessity this unit had to be located near the point of use, but it logically came under the control of the power department. As we had automatic control of the temperature and pressure in the system, it was felt that, if alarms could be provided to warn the power department of any failure of service, the constant attendance of an operator could be dispensed with. Accordingly, we worked out the three alarms as follows: First is an alarm for the steam supply. As is the case with the other two alarms, this is of the Bristol indicating type with electrical contact points which may be set as desired and which complete a circuit through the indicating hand when the instrument goes above or below the desired limits. This alarm is connected to the steam-supply line between the reducing valve and the heaters and will give warning of failure either of the source of supply or the reducing valve.

The next alarm operates from the 300-lb. pressure maintained in the system. With two pumps in the line there is little chance for a complete failure of service, but there have been excessive leaks at various times due to operating conditions. At such times this alarm calls the power-department operator, who stands by until the trouble is corrected.

The third is on the hot-water temperature. It might seem that this is, in a way, a duplication of the alarm on the incoming steam, but this is not really so. In the same way as with the pressure, operating conditions may cause serious leaks which put an abnormal demand on the system. At such times it is desirable to have an operator on watch. These abnormal leaks naturally reduce the temperature as well as, and often long before, the pressure. As we have already pointed out, maintenance of temperature is essential for a correct tire cure.

Automatic Control Lowers Repair Costs

It is an interesting fact that we have had less repair costs for the upkeep of the system since it was left to operate automatically. A man with but little to do is bound to tinker a bit, and we all know that it is better to let machinery that is running right strictly alone until such time as it begins to give evidence of needing attention. This item is one that has often been overlooked in discussions of automatic control.

We have also obtained better and more uniform regulation both of temperature and pressure. So our saving has been threefold—first on the cost of an operator for each of three shifts, second on costs of repairs and third, but not least, on an improvement in operating conditions.

Circuit Breakers for Changing Taps on Transformers

By E. K. Read

Circuit-Breaker Engineer,
Westinghouse Electric & Manufacturing Company

CIRCUIT breakers for changing taps on transformers while they are carrying load operate under conditions quite different from those that are found in usual circuit-breaker practice.

The circuit breakers used are non-automatic, mechanically operated from a cam or similar sequence mech-

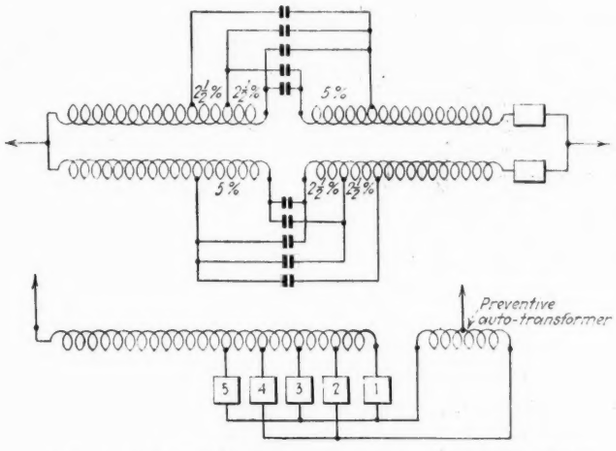


Fig. 1 (Above)—Diagram of transformer with parallel-winding method of tap changing
Fig. 2 (Below)—Single-winding method of tap changing

anism. They must operate many more times than the normal circuit breaker without requiring attention. The normal circuit breaker opens or closes relatively infrequently, and occasionally opens a heavy overload or short circuit. In the latter case it is inspected as soon as it can be cleared. The current values opened by tap-changing circuit breakers are approximately equal to the continuous load on the contacts. The circuit breaker must open and close this current several hundred times without requiring mechanical attention, contact renewal or oil replacement. The voltage across the contacts during the opening is low compared to the insulation required for the normal circuit breaker.

The tap-changing circuit breakers change the taps on a transformer whenever the operator shifts the control switch, or, on automatic equipment, according to the setting of the control relay.

The taps are usually placed in the middle of the delta or at the grounded end of a high-voltage star-connected winding. The number of taps and the voltage between them vary with the application. The circuit breaker used in switching the highest voltage tap must have insulation to ground corresponding to the voltage of the tap above ground. It is usual to provide the same insulation to ground on all taps to the circuit breaker for the sake of uniformity. When the circuit breaker operates the voltage across the contacts is equal to the impedance across the section of winding that is being switched.

Fig. 1 shows the schematic diagram of a tap-changing transformer with the parallel-winding method of tap changing. In this method one half of the high-voltage winding is open-circuited first, then the taps are switched to the new connection and the circuit completed again. The other half of the winding is then open-circuited, its taps changed to correspond with the first half of the winding and then the second half of the winding reconnected. Fig. 2 shows the single-winding method of tap changing. A preventive auto-transformer is used in this method to permit switching from point to point without opening the circuit and to prevent short-circuiting a section of the winding.

For an equipment with five 5 per cent taps in the grounded end of a 76,200-volt winding using the single-winding method of tap changing, the voltage to ground is zero, 3,810, 7,620, 11,430, 15,240 and 19,050 on the respective taps, while the voltage across the circuit-breaker contacts is not greater than zero, 5,400, 7,620, 12,080, 15,240 and 19,400 respectively, at full load and unity power factor. These latter voltages are slightly higher at lower power factors. In changing taps the voltage across the contacts of the circuit breaker which is opening or closing is of the order of 5,400 volts. After the circuit breaker has opened, it must have sufficient insulation to withstand a voltage of 19,400, which will occur if it happens to be the end circuit breaker.

Fig. 3 shows a three-phase tap-changing circuit breaker with one of the oil tanks removed. It has a

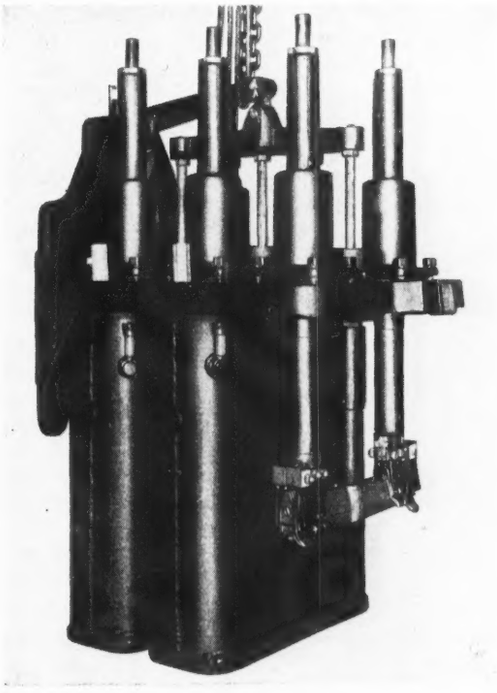


Fig. 3—Three-phase tap-changing circuit breaker

heavy base to give a firm foundation, condenser terminals that are not subject to breakage from shock or vibration, and finger contacts that give a long life and do not require accurate adjustment. The condenser terminals are equipped with machined flanges bolted against the machined base to prevent displacement. The arcing contacts are of a special form designed to give a long life before arcing will occur on the main contacts.

An operation counter is usually supplied with each breaker so the maintenance can be scheduled to care for the circuit breaker after a definite number of operations, and also to permit the keeping of an accurate record of the performance of the unit.

Deep-Well Pump Operates Against 640-ft. Head

DEEP-WELL pumps are used for a wide variety of services to supply water for municipalities, industrial plants, irrigation, ice plants, hospitals, hotels, railroads, mines and other purposes. An outstanding example of such pumps is that recently made by the Etiwanda Water Company, Etiwanda, Calif. This unit consists of an 1,800-g.p.m. Pomona water-lubricated turbine pump, for operation under a 640-ft. head, driven by a 350-hp. 950-r.p.m. vertical Westinghouse induction motor.

The motor is shown in Fig. 1 and a pump cross-section and well in Fig. 2. As can be seen in Fig. 2, the pumping unit is made of two pumps. The lower one, which is a fifteen-stage seventeen-inch lift pump, is fifteen feet long and is located 476 ft. from the top of the well, which is 800 ft. deep. Placed 450 ft. above the lift pump is a six-stage seventeen, inch turbine booster pump that delivers the water against a head of 190 ft. above the surface, to the top of a hill, and thence distributed for irrigation and municipal purposes. With 190 ft. of the head above the surface, 450 ft. is left to be taken care of in the well.

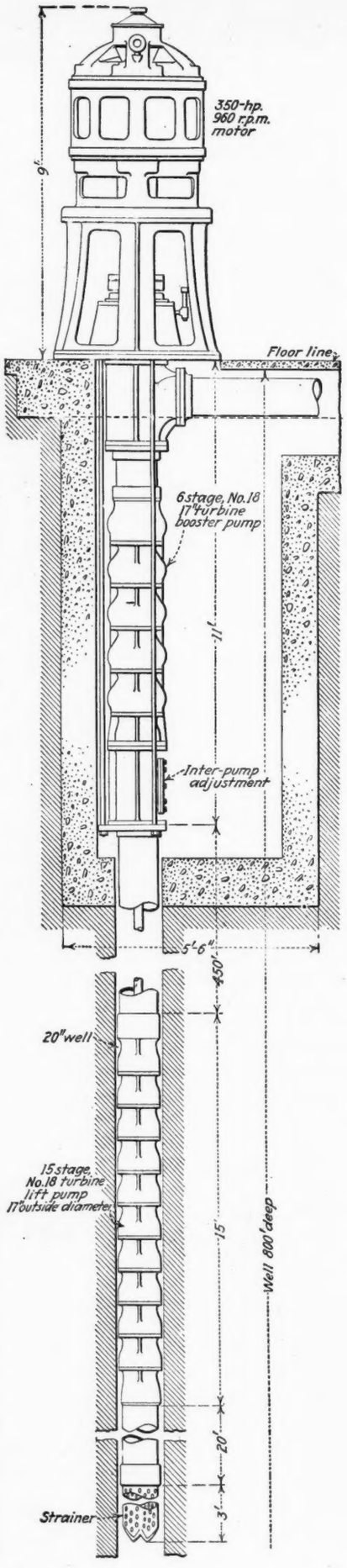
The pump is one of the largest deep-well type ever constructed and weighs 60,000 lb. A novel feature is the water-lubricated bearings. There is no metal-to-metal contact in the bearings. The pumpshaft bearing sleeves are made from a special non-corrosive metal. The lineshaft bearings are of the floating resilient type made from a rubber composition, and the turbine bowl bearings are of the roller rubber type. With this construction there is little tendency for sand or sediment floating in the water to become lodged and cut the shaft or bearings. The Etiwanda pump has been in continuous operation for over five months without shutting down. Since the bearings are water-lubricated, there is no lubricating oil to get into the water.

Of the semi-open type, the propellers are made of cast phosphor bronze, accurately balanced and hand-finished. These propellers are assembled on a special non-corroding shaft and run in a cone-shaped seat. By turning an adjustment nut at the top of the pump head, the runners can be slightly raised to reduce the capacity of the pump, without seriously affecting the efficiency. If, at a later date, it is necessary to lower the runners to meet a lower water level, the runner can be readjusted to pump a greater or less capacity as desired. This feature allows adjusting the clearance between the runners and their bowls to compensate for wear.

The motor is of the squirrel-cage induction type, mounted on the discharge head of the pump and connected to the runner shaft by a flexible coupling.

Fig. 1 (Left)—Vertical six-pole induction motor rated at 350 hp. at 960 r.p.m., connected to the turbine pump's discharge head of the flexible-coupling type, installed for the Etiwanda Water Company, California.

Fig. 2 (Right)—Cross-section of the well, showing the general arrangement of the pumps and motor. The figure does not show the Etiwanda pump, but a similar arrangement used in another well. The dimensions are correct for the Etiwanda installation.



Letters From an Oil-Engine Operator

A Cheap Engineer Is Expensive

Dear Ed: I received your last letter and I imagine you are up against a proposition like that at the Arrow Head Paper Mills down at Stone Creek.

Jim Hyde, who is on his own as a consulting engineer out in Pittsburgh, recommended to them that I come down and look the plant over, since I have time for such things the way our job is running.

From beginning to end it was the worst piece of mismanagement and poor judgment I ever encountered. The Arrow Head made the foundations shallower than the oil-engine builder recommended, this being the beginning of a program of economy that was carried to the extreme.

I understand that when the erector came on the job, he sounded the soil and found that one side of one engine would extend out to the edge of an old fill over swampy ground. He kicked like a bay steer about this, but to no avail. They insisted that the plant had to go in operation at once and there would be no change in the foundation. I do not think that the erector's firm knew how bad it was or it would have given him just a little more support.

When this chap finished the installation, he stayed with the plant as chief engineer for a year and everything worked well. The owners were well satisfied, but they hated like sin to pay his price. Eventually, they let him go and put a fireman out of the steam plant in his place, paying 42 cents an hour. Imagine such a man placed in charge of a 900-hp. oil-engine plant.

From that time on things went bad. The place was filthy, dirty; fuel and lubricating oil leaks left the floor greasy and the engineers would put sawdust around the engines to absorb it, but never mop it up. Every thermometer was broken. The instruments on the switchboard were all out of order, and there was no way of telling what the load was. They considered such conditions of minor importance. They had managed to disagree with the engine builders, who had sent one service man after another out there in an attempt to induce them to change the policy of operation, but to no avail.

One of these fellows—Snyder was his name—pointed out that one of the engine foundations was settling, that the air gaps in the generator on this engine were far from equal and that the flywheel bearing was heating. They told him that when they wanted advice they would ask for it.

The engine company became disgusted with the whole job, knowing that what would eventually transpire would not help its reputation in the least.

Arrow Head carried on in their own bull-headed way until one of the engines would not start. Finally, they asked for a service man and he found that the silencers were clogged up with carbon. He read the riot act to them for fair. Told them to get some good lubricating oil, keep the fuel pumps adjusted, the load equally distributed between the three engines and hire a capable engineer. He spent two weeks getting that plant in shape and raised the question of that bad foundation once again.

Things went on this way for two years in which a service man was either coming to, going from, or working in the plant. Mind you, the Arrow Head refused to pay for his services, when he was really the brains of the plant.

I do not blame the engine builder a bit, although I was hired to try to find some means of proving that it had not done the right thing and the Arrow people thought that engineers, like expert witnesses, should side in with the payers of their fees.

This was after the builder had shut down on service. I was told that the engine builder wrote, saying that unless the Arrow Head outfit would do as advised by the service men and also meet their delinquent payments on the engines, no more service would be forthcoming. As a result of this the two firms locked horns and a lawsuit instituted by the engine builder in an attempt to collect the balance due on the engines, appeared unavoidable.

Before the case went to court the bad foundation gave way and the engine settled at one corner. A bearing melted out, the crankshaft settled and a crank box melted. A piston seized and a connecting rod went through the engine frame. I guess the engineer must have been out rabbit shooting or fishing. He surely was not in the engine room.

They stripped that engine and used the parts to fix up the other two that were becoming troublesome. These two were overloaded through carrying the full load when I came to the plant to help them out.

They did not want help. What they wanted was for me to find something about the installation that was wrong and directly chargeable to the engine builders.

I told them the only way they could get out of this mixup was to pay up their bills and co-operate with the engine builders, and incidentally I gave them about the same advice relative to methods of operation that the service men had been giving. At first they were ready to throw me out, but finally listened to a proposition.

I got in touch with Tom Kennedy and put it up to him to take over the operation of the plant. The Arrow Head agreed to recondition the plant and then let Tom operate, crediting 1½c. per kilowatt-hour for the current produced, which was about the amount asked by a central power station with whom they had been negotiating.

The Arrow Head people agreed to pay up if Tom could make the plant pay; the engine builder agreed to wait and see how matters turned out before pressing the suit. The little joker in this deal is that Tom gets $250 a month and 10 per cent of the difference between 1½c. per kw.-hr. and what it actually costs to produce power.

Figure it out. I know he can deliver power on the line for less than a cent per kilowatt-hour and they use 6,000 kw.-hr. a day. The bonus will be not less than $90 a month.

The last time I saw Tom, he said that the red ink was rapidly disappearing from the ledger. His wife has already picked a new sedan to come out of the bonus.

This just goes to show what can be done when teamwork starts.

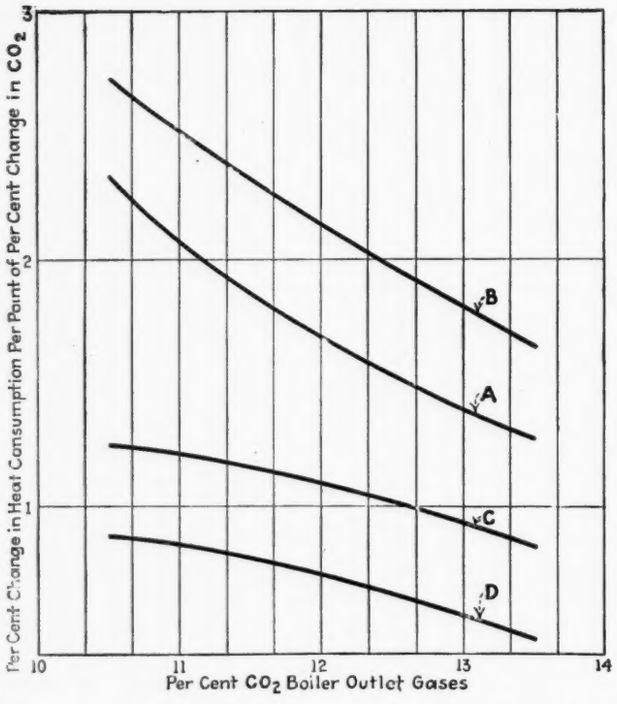
E. O. LESEID.

Note—This letter outlines a condition that sometimes exists in the power-plant field. Too many firms, after investing capital in new equipment, forthwith refuse to give the machinery the care its value justifies. It is not to be wondered at, that the machines soon become junk. But is there not a duty on the part of the equipment builder? Should he be willing to sell to a firm unless he is satisfied that his product will be properly handled? Or is this asking too much self restraint of the salesman? —Editor.

Effect of CO_2 on Plant Economy

By B. C. SPRAGUE
West Penn Electric Company

MUCH has been published regarding the effect of variations in the percentage of CO_2 in boiler outlet gases on the efficiency of boilers. Although there is no doubt that all this information is correct for the conditions assumed, it is frequently misleading to those who do not understand the relation between excess air and boiler efficiency. Some operators have striven to obtain the highest possible values of CO_2 percentage, regardless of the effect of this kind of operation upon the combustible losses. As a result in many cases, the combustible losses are increased so greatly that the efficiency of



Effect of CO_2 on plant economy

the unit is appreciably less than would have been obtained with a lower value of CO_2 percentage.

Most of the data that have been presented to show the relation between CO_2 and efficiency have been based on the assumption that the weight of gas was the only factor affected. In any given boiler installation an arbitrary change in CO_2 percentage, while maintaining a constant, output of steam, will result in changes in the following factors, each of which has a bearing on the economy of the plant: (1) The temperature of the boiler outlet gases; (2) the temperature rise of the water in the economizer; (3) the temperature rise of the air in the air heater; (4) the temperature of the superheated steam; (5) the combustible in the refuse in stoker-fired boilers; (6) the amount of combustible gas in the flue gas.

The relation between CO_2 and the first four factors is consistent for any given installation. To establish these relations it is only necessary to make a few simple tests or to apply data obtained elsewhere on similar equipment. The effect of CO_2 variations on the last two factors is, however, more difficult to determine. These effects vary with the method of operation and the kind of fuel burned. In order to establish these relations it is necessary to make many tests in order to exclude the effect of chance variations and to make sure the results obtained are representative of the conditions that will obtain in normal operation.

Where CO_2 recorders or steam-flow air-flow meters are available and where representative daily ash samples can be obtained without too much expense, tests to determine the relation of CO_2 and the combustible losses can be made at a small cost and without interfering with the boiler operation. It is simply necessary to operate for periods of a week or more, with different values of CO_2, on one or more units, taking care that the loading of the boilers is approximately the same for each period.

In large boiler plants where a testing organization can be economically maintained, it is considered desirable to obtain records of the CO_2 and combustible in the refuse from all boilers and to make studies of the relation betweer CO_2 and the combustible losses almost continuously. Variations in the fuel being burned and in the methods are almost constantly affecting the relations between CO_2 and the combustible losses. It is only by studying these relations that the best performance can be obtained. In smaller plants the relations between these factors can be studied on a single boiler from time to time and the results used in guiding the operation during the interval between these studies.

Variations in CO_2, in addition to affecting efficiency, also in many cases have some bearing on the maintenance costs. It is seldom possible to determine the effect on maintenance costs directly by operating with given CO_2 percentages. These relations have to be approximated by estimating the effect upon maintenance costs of the furnace conditions that are obtained with the different values of CO_2.

Before studying the relation of CO_2 and combustible losses, it is advisable to determine the relation between CO_2 and the factors that are more definitely affected by changes in excess air. The figure shows the results of these determinations for a 16-tube high water-tube boiler equipped with an interdeck superheater and a 60 per cent steel-tube economizer.

Curve *A* shows the effect of CO_2 on the boiler economy based on the assumption that there is no change in any of the other factors excepting that of the weight of the products of combustion. In this case temperature of the outlet gas is taken as 650 deg. F., and no allowance is made for the economizer. This is the curve that is usually given to show the effect of CO_2 on efficiency. Curve *B* is similar to curve *A* excepting that allowance has been made for the variation of the temperature of the outlet gas resulting from changes in CO_2. The boiler outlet temperature is taken as 650 deg. F. in the case when the CO_2 is 12 per cent.

In curve *C* allowance is made for all other factors excepting those of superheat and combustible losses. In correcting for the effect of variations of superheat on the turbine efficiency, a change of 1 per cent in plant economy per 30 deg. change in superheat was assumed. Curve *D* shows the effect of CO_2 variation on all the more definite factors, excluding the effect of the combustible losses.

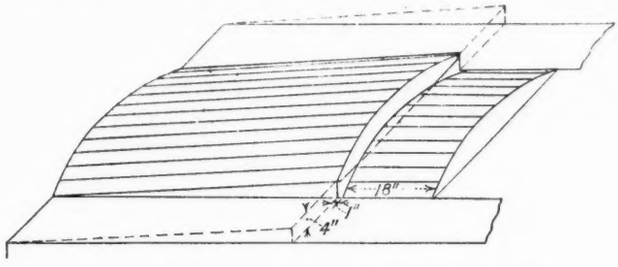
It will be seen that the reduction in boiler outlet temperature resulting from an increase in CO_2 greatly increases the gain in economy. Where economizers are used, the gain from improved CO_2 is so greatly diminished that the net effect after correcting for the effect of the changed superheat is so small that it can easily be offset by the increase in combustible losses that generally occur when the excess air is diminished.

Right Out of the Plant

BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

Experiences with Ignition Arches

THE sprung ignition arches under our new water-tube boilers have given considerable trouble by frequently falling into the furnace. Our own masons rebuilt them with much care and according to plans, but still they failed. We tried a flat-suspended arch, which was installed by experts. The brick spalled badly at first, but we were able to stop this trouble. The suspending steel, beams, etc., warped badly and had to be replaced. One and a half year's use of this arch was enough. It showed no advantage over the sprung arch and cost more to keep in repair. In the meantime we were trying to make the sprung arches stand up. We tried different kinds of



Form on which the sprung arch was built, showing position of short independent brick arch

brick and clay. This seemed to make some difference. Still the arches failed to give reasonable service.

Fireclay shrinks in burning, the amount of shrinking depending upon the proportion of unburned to burned clay used. If the bricks in the arch rest upon the fireclay, the arch will, of course, settle by the combined shrinkage of the joints. Hence the bricks should be fitted together and the clay used only to seal the joints. If the plasticity of the brick at high temperatures is considered, it is easy to understand why sprung arches fail.

There was not much room for these arches, so that little change could be made in their form. We raised the arch as much as possible, which helped some. The back end of the arch after a few runs would droop down and bricks fall out—sometimes singly, sometimes in groups. Repairing was like "putting new cloth into old garments." Most of the arch was good, but we couldn't get along without the back end of it. We then blocked up the back end of the arch form four inches, as shown in the illustration, and built an independent arch eighteen inches long over the back end of the ignition arch, but four inches lower than it. It had the same spring and was built like the other arch, with the bricks carefully fitted and tied together. The arches were separated about one inch. The space between the arches was covered over loosely with tile or brick. The short arches were built to take part of the wear off the ignition arches. This they did surprisingly well, and our arches gave little subsequent trouble. The short arches became intensely hot in use, but they were uniformly hot. The sprung ignition arch is a distorted affair with one end hot and the other comparatively cool. The wonder is that the structure stands the abuse as long as it does. The short arches did not wear away as rapidly as we expected. When necessary, they were quickly and cheaply replaced.

Elgin, Illinois. W. L. PARKER.

Constant-Speed Motor Unsatisfactory on Machine with Flywheel

THE duty cycle of many machines comprises a period of heavy load followed by one of light load. Frequently, on such applications a flywheel can be used to good advantage to reduce the load fluctuations. In addition to this a smaller motor can be used and more satisfactory operation obtained than without the flywheel. Before a flywheel application can be satisfactory, the motor must have a drooping speed characteristic.

For the flywheel to deliver energy to the load, it must slow down. To absorb energy, the flywheel must have its speed increased. To accomplish this, the motor must slow down and shirk load during the peaks and let the flywheel supply part of the energy to drive the machine. When the peak has passed, the motor speeds up and stores energy in the flywheel to help carry the next peak

From the foregoing it is evident that a constant-speed motor cannot be satisfactory for a machine that requires a flywheel. A synchronous motor cannot be used on this type of drive. This type of motor has a fixed speed determined by the circuit's frequency and cannot slow down unless it is pulled out of step. Low-resistance rotor induction motors and shunt direct-current motors are also not suited to this kind of drive, because of their small speed variation between no load and full load.

On a large press operation was unsatisfactory because of frequent breaking of parts, heating of the motor and heavy power surges in the line. The motor was of the wound-rotor induction type. A suitable resistance was obtained and connected permanently in series with the rotor leads. Increasing the rotor's resistance caused its speed to decrease faster with an increase in load and allow the flywheel to absorb a greater portion of the peak. This not only reduced the load on the motor, but relieved the strain on the machine during operation.

Squirrel-cage motors for driving such loads should have a comparatively high-resistance rotor. If the rotor has a low resistance, a sufficient resistance should be connected in the stator circuit to give the desired droop to the speed-torque curve. For direct-current motor applications a compound-wound type should be used, with sufficient compounding to produce the necessary slowing down of the motor with increased load.

These applications should not be confused with compressor drives, where a flywheel is used to absorb the load variations during each revolution of the crankshaft. In these applications constant-speed motors are used with entire satisfaction, as witnessed by the extensive employment of synchronous motors.

Cleveland, Ohio. M. E. WAGNER.

As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Why Scrape a Bearing to Fit?

IN THE Nov. 13 issue of *Power* W. G. Forbes comments on my previous article, "Why Scrape a Bearing to Fit?" I still hold to the view expressed in the article.

I am informed that owing to correct design, accurate machining and careful workmanship throughout, the bearings of steam turbines are not "scraped in." When scraping was resorted to, it was necessary because of some misadjustment that happened after the turbine had been running, or because of a possible "high spot."

Again, I have been told by capable erecting engineers, that tool marks were still visible in the bearings of rotors of large steam turbines, even after having run almost continuously for a year. "Tool marks" does not mean scraper marks, as may perhaps be thought.

The same thing applies to engine slide valves and their seats. Plane the seats in one direction and the faces of the valves in the right-angle direction. When the engine first goes into operation feed plenty of oil to the valve and seat and let them gradually wear to each other under the operating conditions. This seems more reasonable than spending a lot of time scraping the valve and seat while they are cold, producing a relatively smooth hard surface which, when it becomes warped with the heat, will take much longer to work up to a steam-tight fit.

As I have already stated, except in machines where extreme accuracy is demanded, scraping bearings is in my opinion unnecessary.

Brooklyn, N. Y. CHARLES J. MASON.

* * * *

A Matter of Definition

THE editorial entitled "A Matter of Definition," in the Nov. 20 issue, was much to the point, for frequently there are occasions when misconceptions are made with regard to the capacities of a power-plant engineer.

It is obvious, however, that the term power plant should not only embody the buildings and equipment necessary for power generation, but should incorporate the generation, transmission and application of power in industrial plants.

In perusing a book recently, entitled "Modern Power Engineering," I observed the following subjects fully dealt with: The application of the steam engine, driving electric generators and locomotives, steam turbines, engine-room auxiliaries, steam-condensing plants, internal-combustion engines, horizontal and high-powered gas engines, gas producers, oil engines, the steam locomotive, reciprocating steam engines, pumping engines, the marine engine, water power, steam boilers and fittings, the combustion of coal, oil fuel and other boiler fuels and engineering calculations. Obviously, the work of a power engineer is of a wide and varied nature as the subjects mention indicate. To this list might be added Diesel-electric engines, motor-driven compressors, mechanical-stoker drives, refrigeration and other modern plant equipment.

In conclusion, it may be safely stated that the field of the power engineer is not only large, but is constantly increasing in the industrial and commercial life of the world. A. EMERSON.

London, Eng.

* * * *

Using Condensate for Sealing Turbine Glands

I WAS much interested in the article by W. L. Parker in the Dec. 4 issue relative to the cooling of water for use in connection with steam-turbine sealing glands. I presume the type of condenser in use with the turbines Mr. Parker refers to were of the jet type.

Where surface condensers are used and suitable water for sealing purposes is desired, it is only necessary to tap the condenser hotwell discharge to the heater or surge tank. In nearly all installations the hotwell pumps are designed to take care of static head sufficient to insure proper gland water pressure, which obviates the necessity of an additional pump being used for that purpose.

If the condensers, as aforementioned, are of the jet type, of course it is necessary to resort to some such method as illustrated by Mr. Parker.

Louisville, Ky. JOHN F. HURST.

* * * *

On the Use of Water Softeners

I HAVE been greatly interested in the articles on the use of water softeners by E. O. Leseid in the Nov. 6 issue and A. C. Embshoff in the issue of Nov. 20.

It is apparent that both have overlooked the deciding factor in the question of whether lime-soda-aluminate treatment or zeolite treatment would be more satisfactory for treating cooling water in Diesel engines. This factor is the raw-water analysis, or the physical and chemical makeup of the water to be treated.

With zeolite treatment the sulphates of calcium and magnesium are converted to sodium sulphate and the bicarbonates of calcium and magnesium are converted to sodium bicarbonate. As pointed out by Powell in his book, "Boiler Feed Water Purification," "zero water" is a misnomer, for even with the most careful operation there will be traces of hardness left in the water after zeolite treatment. This hardness will, of course, concentrate in the cooling tower.

Within lime-soda-aluminate treatment the sulphates of calcium and magnesium are converted to sodium sulphate, as in zeolite treatment. The bicarbonates of calcium and magnesium are eliminated, and in their place we have a carbonate hardness remaining of from 0.2 to 1.0 grain and from 1.0 to 2.0 grains of sodium hydroxide and 0.5 to 1.0 grain of sodium carbonate.

Encrusting sulphates are removed more cheaply with zeolite, whereas the bicarbonate hardness is removed more cheaply with lime and sodium aluminate. Water

going to a zeolite softener should be free from iron, suspended matter and normal carbonates.

Thus we see that a water containing practically all sulphate hardness should be treated by zeolite, while a bicarbonate water should be treated with lime-aluminate. Most waters are combination of these two hardnesses, and the proper treatment should depend on their ratios.

After the water reaches the tower, it will become contaminated with dust, soot and CO_2, and it should be bled at frequent intervals to reduce the concentration. This is true with either type of softener. In zeolite-treated water the CO_2 will exist as such, and in the lime-soda-aluminate water it will combine with the caustic alkalinity, as Mr. Embshoff pointed out, but will form sodium carbonate and not calcium carbonate, inasmuch as it is combining with sodium hydroxide and not calcium hydroxide. This naturally makes a less corrosive water than the zeolite-treated water, where the CO_2 has nothing to react with.

I hope that the foregoing information will help clear up some of the points in question.

H. A. GUSTIN,
Water Service Engineer,
Chicago, Ill. National Aluminate Corporation.

* * * *

Some Causes for the Failure of Fusible Plugs

I READ, with interest, the article by W. E. Warner in the Nov. 20 issue, on "Some Causes for the Failure of Fusible Plugs." As I have had considerable experience in investigating the failure and deterioration of fusible boiler plugs during the last few years, I venture a few notes on the subject.

In the first place, it can be safely said that the failure of fusible boiler plugs is due to various causes other than those mentioned in the article referred to. As is well known, the function of a fusible plug is to indicate when low water exists. The moment water in the boiler becomes sufficiently low to expose the crown plate to the direct attack of the fire heat, it being unprotected by water, the temperature at this point increases rapidly, causing the fusible metal to melt and flow out through the opening in the bottom of the plug. Water and steam will flow out through the opening and extinguish the fire or otherwise render the boiler useless without further damage. This may also be the means of avoiding the rupture of the crown plate and possibly of averting a boiler explosion.

If the fusible plug is to retain its efficiency, perform its function and prove an element of safety when there is danger by excessive pressure, it is obvious that it must be given the proper attention. Unfortunately, many boiler attendants appear to be under the impression that, once a plug has been screwed into the plate, its existence and function may be forgotten. To this impression is largely due the somewhat customary belief that fusible plugs are not reliable. Experience shows that a fusible plug is likely to become scaled on the water side and coated with soot and dirt deposit on the fire side. It is also subject to corrosion and the fusible core may be affected in course of time by long exposure to the action of the furnace gases. When a fusible plug is permitted to be in this condition, it is practically impossible for it to act at the critical moment. Frequent cleaning is really a matter of paramount importance, as also is occasional changing of the fusible core of alloy or metal. It is the practice in our plant to examine fusible boiler plugs every three months and to replace them with new ones at least once a year.

The corrosion of the brass or gun-metal case containing the core of fusible metal often takes place, and severe wastage will sometimes occur, particularly around the threaded part, where the plug is screwed into the shell of the boiler. I have known leakage from this cause so serious as to necessitate the shutting down of the boiler.

Another cause of failure of fusible boiler plugs is the lack of cohesion and loosening of the plug filling in the outer cases. This is due entirely to improper filling methods and can be prevented by thoroughly cleaning, preheating and tinning the plug interior before pouring the fusible metal or alloy into the plug.

Although the ordinary procedure in filling and refilling new and used boiler plugs is fairly well understood, the following details are important: (1) Properly cleaning and tinning the gun metal or brass plug interior; (2) correct preheating of the outer casing prior to tinning and filling; (3) correct melting and pouring temperature of the fusible metal or alloy; (4) reliability of source of supply of the filling metal.

Overheating during the melting process is not only detrimental to the plug-filling material, but also causes waste of the tin content (when present) through the excessive production of oxide. Furthermore, tin oxide has a comparatively high melting point and is exceedingly hard.

Experience shows that too much care cannot be taken in cleaning, fluxing and tinning the plug interior to secure perfect adhesion of the fusible metal. In practice it is found that immediate filling without intermediate cooling, is desirable for good adhesion of the fusible metal to the plug.

I have been questioned many times during recent years as to the best filling for fusible plugs. Practice has almost invariably shown that pure banca tin gives the best results, as it will remain in a serviceable condition longer than any of the alloys whose melting point is at all suitable. Pure tin may be depended upon to melt promptly at about 450 deg. F., which corresponds to a boiler pressure of 365 lb. per sq.in. Lead and zinc in tin fillings are detrimental impurities and should be eliminated by strict specifications and inspection, which would allow only admittedly superior qualities of tin to be used.

Pure lead alone is sometimes used for steam boiler plug fillings and many fusible alloys, the latter usually consisting of tin, bismuth, cadmium and lead, the proportions varying so that the alloy will melt out at a little above the temperature of the working steam pressure.

The alloys that have been tried for steam-boiler fusible plugs appear to undergo a gradual change when exposed continuously to heat, so that their melting points do not remain constant. In order to guard against this risk, frequent removal of the plugs and renewal of the fusible alloy is desirable. This is not a costly procedure, and it is decidedly better to incur the expense of renewals than to run the risk of having to close down the boiler.

Manchester, England. E. ANDREWS.

CORRECTION—In the discussion letter "On the Use of Water Softeners," appearing in the Nov. 20 issue, it was incorrectly stated that the author A. C. Embshoff was connected with the International Nickel Company. Mr. Embshoff is with the International Filter Company and has never been connected with the International Nickel Company.

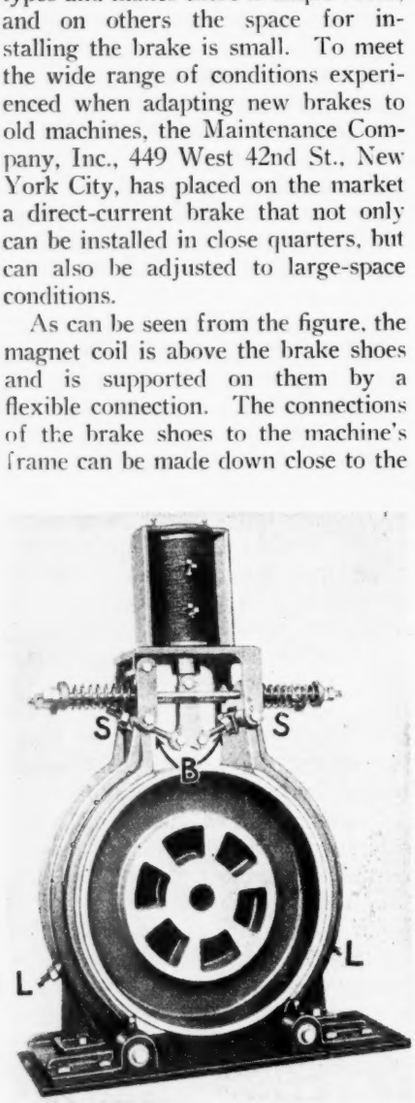
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Elevator Brakes for Wide Range of Applications

THE mechanical limitations under which brakes are applied to elevator machines vary widely. On some types and makes there is ample room, and on others the space for installing the brake is small. To meet the wide range of conditions experienced when adapting new brakes to old machines, the Maintenance Company, Inc., 449 West 42nd St., New York City, has placed on the market a direct-current brake that not only can be installed in close quarters, but can also be adjusted to large-space conditions.

As can be seen from the figure, the magnet coil is above the brake shoes and is supported on them by a flexible connection. The connections of the brake shoes to the machine's frame can be made down close to the



Brake can be installed in close quarters

bedplate as in the figure, thus allowing the brake to be installed where the brake wheel has small clearance from the plate. For larger clearances between the brake wheel and bedplate the brake can be adjusted to the height of the wheel by suitable plates under its feet. The shoes are of cast iron, lined with high-grade brake leather.

Proper clearances of the shoes on the brake wheel are obtained by adjusting the eyebolts *B* and the back stops *L*. By adjusting the springs *S* the required tension of the brake shoes on the wheel is obtained.

The brake has been designed to replace unsatisfactory electro-mechanical and band brakes, which are difficult to keep in adjustment. It can also be used to replace mechanical brakes with or without conversion to electric control.

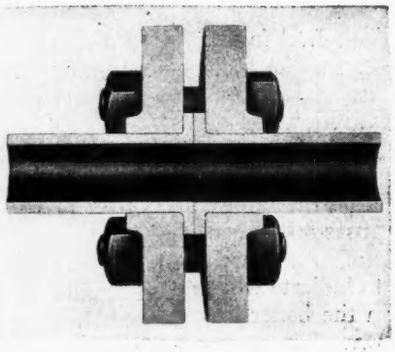


Fig. 1. Flanged joint applied to a ½-in. drain line

Flanged Pipe Joints for Drips, Drains and Bypasses

TO MAKE the standard types of high-pressure flanged joints adaptable for use on drains, bypasses and other steam lines below 2 in. in diameter, the National Valve Manufacturing Company, Pittsburgh, Pa., has developed the joints shown in the illustrations.

The Van Stone joint shown in Fig. 1 is ½-in. size, and is designed to withstand any present-day operating pressure and temperature. The lap has a thickness equal to that of the tubing from which it is formed, even after facing the front and back of the flange. This back facing is important, inasmuch as it insures correct alignment. The radius of the flange and that of the lap are concentric, thus giving proper bearing to the flange. It is pointed out by the manufacturer that tests recently made on this joint and the cup-welded joint shown in Fig. 2, showed an average ultimate tensile strength of 60,000 lb. per square inch.

Fig. 3 shows a practical method of

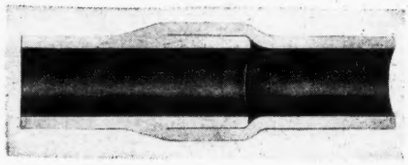


Fig. 2. Cup-welded joints

Fig. 3. Flanged joint with cup ends on pipe

installing the flanged joint. Sections can be furnished as short as nine inches from face of lap to face of cupped end. The important advantage of this type of joint on high-pressure drains, bypasses, etc., is the ease with which the line can be erected or dismantled.

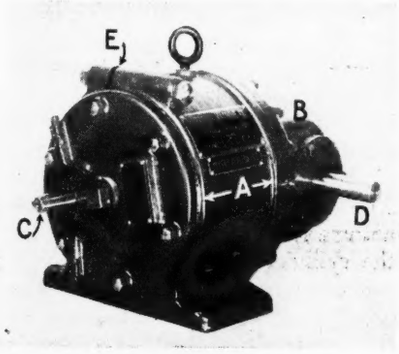
Silent Chain Drives up to 60 Hp. Available from Stock

AN INCREASE in the size of silent chain drives which are available from stock was recently announced by the Link-Belt Company, Chicago, Ill.

It is now possible to obtain drives from ½ to 60 hp. in practically any reduction from 1 to 1 to 7 to 1 directly from stock. This line of drives is, of course, exclusive of the larger capacity drives, which the company furnishes in sizes up to 1,000 hp. and over.

Helical-Gear, Right-Angle Speed Reducer

TO MAKE its line of helical-gear speed reducers applicable to drives where the slow-speed drive-shaft must be at right angles to the high-speed shaft, the Morrison Machine Company, Paterson, N. J., has brought out the models A.R.U. and



Speed reducer in which the high- and low-speed shafts are adjustable

A.R.P., the former being illustrated herewith.

The helical-gear reduction section *A* of the unit, which was illustrated and described in the March 13 issue, forms the essential part of the new unit, the section *B* comprising the right-angle drive being added to it.

As pointed out in the previous description, the outstanding feature of the unit is the quick adjustability of the high-speed shaft *C* to suit the motor to which it is to be connected. This is accomplished by loosening the clamp *E* on the top of the housing and rotating the complete gear train until the shaft *C* is at the proper height, then clamping it in position. The illustration shows the gear train turned clockwise from the vertical center line until the shaft *C* is slightly below the center line of the gear. This feature obviates the necessity for shims under the feet of the motor or the reducer in order to bring the shafts into alignment.

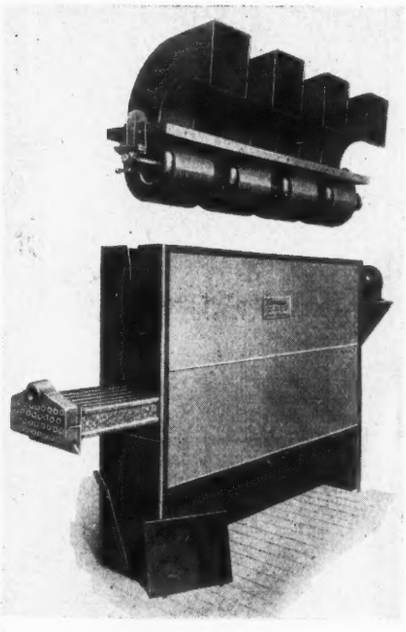
In the new unit the slow-speed shaft *D* is also adjustable to any one of eight positions, these being vertical above and below, horizontal on either side and at 45 deg. from the horizontal in any direction. Anti-friction bearings are used throughout, and the elimination of stuffing boxes is accomplished through the adoption of a special oil seal.

The new unit is made in a number of sizes and capacities in ratios from 6 to 1 to 1,458 to 1.

"Sirocco" Unit Heaters

INDUSTRIAL unit heaters for floor and ceiling application, both high- and low-pressure types, are now being put out by the American Blower Corporation, Detroit, Michigan, under the trade name of "Sirocco." The fan assembly consists of a battery of duplicate double-inlet fans mounted on a structural-steel top panel. The fans are supported from the top panel by means of brackets. As shown in the illustration, removal of the entire battery of fans with the shaft and bearings from the assembled heater can be effected as a unit. This construction tends to facilitate the care and replacement of the bearings.

The heating element is composed



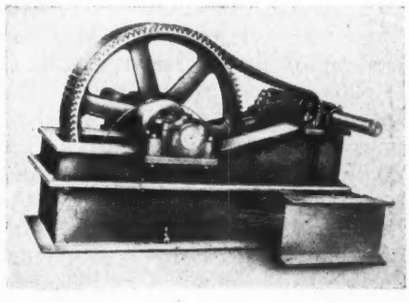
Unit heater with removable fan unit and heating element

of staggered rows of copper fin tubes expanded into one-piece cast-iron headers, the copper tubes being $\frac{3}{4}$-in. in outside diameter, with a flat, continuous fin $\frac{3}{4}$ in. deep metallically attached to each. The heating element, four rows of tubes deep, is supplied for low- and medium-pressure operation. One with three rows of tubes is ordinarily furnished for high-pressure installations, although the four-row type may be used. The units can also be furnished with pipe-coil heating elements if desired. In each case the element is made to be removable readily as shown. The motor is supported on a sheet-steel bracket in such a manner as to be accessible for inspection and oiling. Both the motor and fan shafts are mounted upon self-aligning ball bearings, and the bearings are supported in cast-steel brackets. A "Mercoid" thermostat can be arranged to start and stop the motor. The unit can also be used to ventilate.

Silent-Chain Speed Reducers

ABILITY to absorb shock and ease of changing the speed ratios are features claimed for the silent-chain speed reducers manufactured by the Morse Chain Company, Ithaca, N. Y. A large sized reducer is illustrated. The feature is a ring oiler, which supplies oil to a reservoir, from which it flows by gravity to a distributor that drops oil on the inside of the chain. Both single- and double-reduction units are built, the latter unit consisting of either two chain drives in series or a single chain drive with a spur-gear drive. The range of maximum horsepowers that can be transmitted at various speeds, when designed for favorable conditions, is as follows: At 3,400 r.p.m., 5 hp. can be transmitted, while for 250 r.p.m., 1,000 hp. can be transmitted.

The sprockets are mounted on machined steel shafts, which run in either roller bearings or plain bearings. The bearings are mounted either in pillow blocks bolted to the cast-iron frame, or in thimbles inserted in machined holes in the frame. One end of each shaft projects through the housing

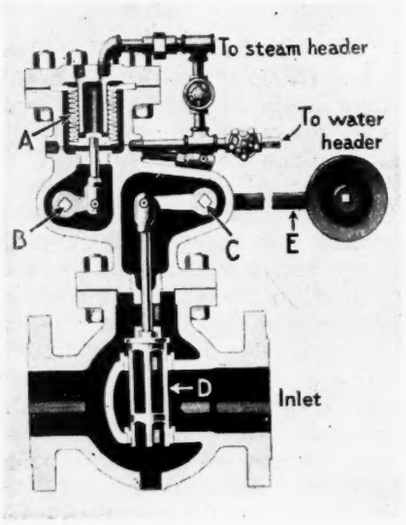


Single-reduction silent-chain speed reducer

and is arranged to take one-half of a flexible coupling. Lubrication of the chains and bearings is automatic. In the smaller units the chain dips into a bath of oil, whereas in the larger units a ring oiler, as shown, is provided. Speed reductions up to ratios of 10 to 1 can be supplied, though for ratios more than 7 to 1 a double-reduction unit is recommended. The drive, it is claimed, has an efficiency of 98.6 per cent.

New Copes Pump Governor

ALTHOUGH designed primarily for use as a pump governor on any type of reciprocating pump and turbine or motor-driven centrifugal pumps, the Copes type DS governor



Type DS pump governor

recently announced by the Northern Equipment Company, Erie, Pa., is suited for differential excess pressure service for boiler feeding; constant pressure service differential reducing-valve service on motor-driven pumps, and relief-valve service on belt- or gear-driven pumps.

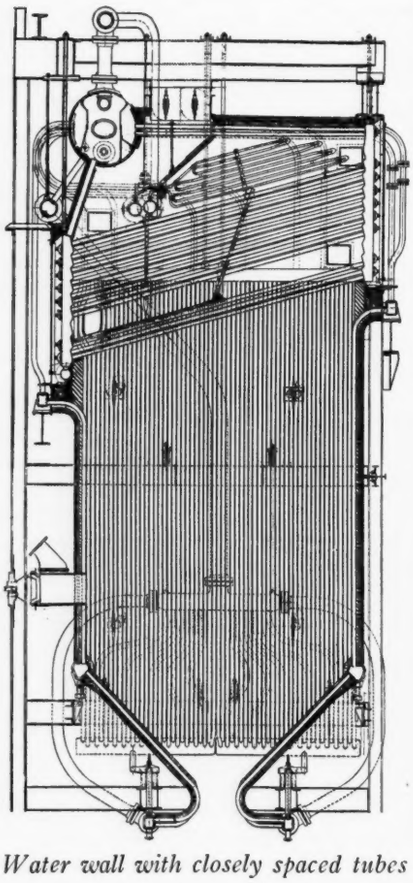
Like the type SS valve, which was illustrated and described in the Dec. 25, 1928, issue, the valve-actuating element of the governor is a brass sylphon bellows shown at *A*. The bellows is designed to withstand an unbalanced pressure of 400 lb. and is unaffected by high steam or water temperatures. The inside of the bellows is subjected to the pressure of the main steam headers and the outside to the pressure of the main water headers.

The bellows is connected, as shown on the cut, through suitable stem and lever to the horizontal spindle *B*, which is in turn connected by means of an outside link to the horizontal shaft *C*. The shaft *C* serves to open or close the valve in response to movement of the bellows *A*. It also carries the weighted lever *E*, by means of which any changes desired in the differential water pressure can be made by moving the weight.

The type DS governor can be furnished in all sizes with straightway or angle style bodies for 250, 400, 600, 900 and 1,350 lb. standards. It can be placed in either horizontal or vertical lines.

Springfield Water Walls

THE accompanying illustration shows a type of water-wall construction put out by the Springfield Boiler Company, Springfield, Ill. The wall embodies, as far as possible, the same materials and methods of construction as employed in the manufacture of the water-tube boilers put out by this company. They are built



Water wall with closely spaced tubes

in sections or panels whenever possible and assembled and tested in the shop and shipped as a complete unit. The walls are designed to suit the particular furnace design and working pressure with which they are to be used, and walls with wide tube spacing or with the tubes so closely spaced that they actually touch are built. The feeder and riser connections from the boiler to the water walls are proportioned to supply the steam-generating surface with an abundance of water without interfering or disturbing the water level in the boiler.

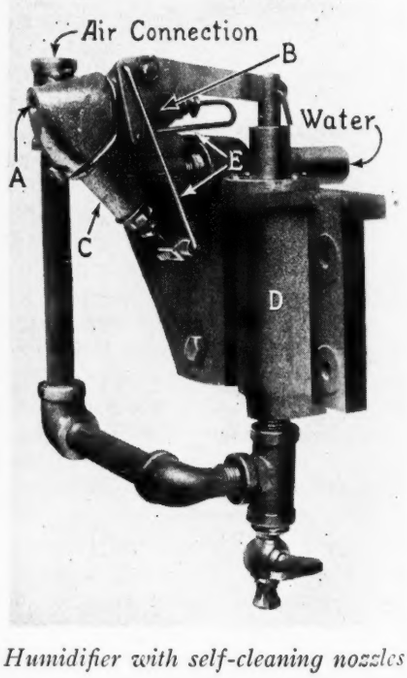
The illustration shows a 10,760-sq.ft. boiler with water-walled furnace and the interconnecting risers between the boiler drum and water-wall headers. The unit is designed to operate at 500 lb. working pressure.

Small Humidifier Unit

SIMPLICITY and small sizes are features of the new humidifier unit recently introduced by the Midwest Filters, Inc., Bradford, Pa.

The unit requires no power other than the compressed air which is used to atomize water supplied to the nozzle. An important feature of the unit is the self-cleaning device, whereby cleaning needles are pushed into the air nozzle *B* and the water nozzle *C* when the humidifier is shut off. The cleaning needles are operated automaticaly by means of a piston in the cylinder *D* connected through a bell crank and links *E*, as indicated on the illustration. This cleaning feature tends to eliminate clogging and corrosion of the nozzles.

A control of the unit is obtained through a humidistat, which regulates diaphragm valves on the water and air lines supplying the humidifier.



Humidifier with self-cleaning nozzles

Provision is made for regulating the amount of water and for each humidifying nozzle by means of an adjustment screw at the outer end of the clean-out needle.

Each humidifier unit can be adjusted to atomize up to 150 lb. of water an hour, depending upon available air and water pressure, and a number of units can be grouped to give any capacity desired.

FROM AMONG THE READERS' PROBLEMS

Conducted
By
L. H. Morrison

LOCATION OF SHUTOFF VALVE ON BOILER FEED LINE.—*One boiler inspector insists that we place a cock on the feed line between the check valve and the boiler. Is this correct?*

R. Q. G.

The inspector was following the American Society of Mechanical Engineers' Boiler Code, which has been adopted in New York State as well as most other states. Paragraph P-314, on page 68 of the Code of the American Society of Mechanical Engineers, states:

"The feed pipe shall be provided with a check valve near the boiler, and a valve or cock between the check valve and the boiler, and when two or more boilers are fed from a common source, there shall also be a globe valve on the branch to each boiler between the check valve and the source so supplied. Whenever globe valves are used on feed piping, the inlet shall be under the disk of the valve."

This permits the check valve to be repaired without draining the boiler.

SPEED CONTROL OF STEAM TURBINE.—*In a steam turbine how is the load automatically taken care of through governors? Assume the machine is idling over and there is a demand for 10,000 hp. What influences the governor to open the valves, and how soon does the turbine come up to speed? Do the revolutions alter very much from one load to another?*

J.R.P.

A governor operates in response to a change in speed. If the speed did not change, the governor would not move to alter the valve opening. Of course, when a heavy load comes on the machine slows down. This causes the governor to open the valve wider and admit more steam, the process continuing until a balance point is reached where the steam supply is adequate to carry the load without a further drop in speed.

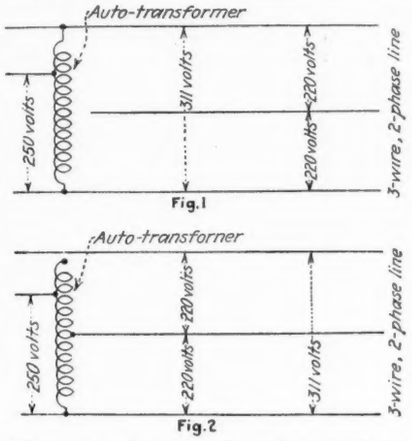
Without any compensating device there is, therefore, a speed for each load, a low speed for high loads and a high speed for low loads. The difference between the low-load speed and the full-load speed is ordinarily not more than 2 or 3 per cent of the average between the two. This is a matter of governor characteristics and can be made almost as small as one may wish if one is willing to run the risk of a hunting governor. This, of course, is a serious matter and must be avoided.

Accordingly, in steam-turbine design for electric generating plants it is customary to use a relay governor with a speed-adjusting device, consisting of a spring backed up by a nut, usually driven by a motor, so that the speed can be adjusted at all times. Whenever there is a change in speed, the operator can quickly bring it back to maintain his frequency at the desired value.

SINGLE-PHASE LOAD ON TWO-PHASE SYSTEM.—*On a 220-volt three-wire two-phase system we connected an auto-transformer across the two outside legs to obtain 250 volts for operating a single-phase motor. Since the voltage between the legs of either phase is 220, across the two phases it is 220 x 1.414 = 311 volts. Therefore the auto-transformer has to step the voltage down to the value required by the motor. Is there any objection to this method of operation and is there a better way of providing for the single-phase load?*

M.E.W.

There is no serious objection to operating the way suggested in Fig. 1. However, with this connection the



Diagrams of connections for obtaining single-phase power from a two-phase system

motor current will be a low power-factor load on the system. Even if the power factor of the motor load were unity, its current would be out of step with the phase voltages by 45 deg. If the motor load had a power factor of 0.71, its current would be 90 deg. out of step with one phase voltage and in phase with the other. For this reason the connection is not to be recommended if the single-phase motor load forms a considerable percentage of the load on the system.

The poor power-factor conditions can be avoided by connecting the auto-transformer to one phase, as in Fig. 2, to step the voltage up from 220 to 250 volts. This connection unbalances the load on the two-phase system, but it will cause less heating of the generator than with the connection Fig. 1.

FLASH OVER ON THE SLIP RINGS OF INDUCTION MOTOR.—*What would cause a wound-rotor induction motor to flash over on the slip rings? We have a motor used in reversing service. When it is operating at full speed in one direction, the controller may be thrown to the reverse position. Would this cause the trouble?*

W. F. R.

When a wound-rotor motor is running at full speed in one direction and is connected for reverse direction of operation, the voltage across the slip rings may increase to double the stand-still value. This is due to the rotor's operating at full speed in a reverse direction to the stator's magnetic field. The high value of the voltage that can exist under these conditions may be the cause of the arcing complained of.

Copper and carbon dust on the insulation may be contributing factors to the trouble. Thoroughly clean the insulation and give it a good coat of insulating varnish. If this does not cure the trouble, more time will have to be allowed for the motor to slow down before it is reversed. If this is not done, then the rings should be reinsulated in such a way as to increase the length of the insulation surface between the rings.

A Question For Our Readers

IF AN operating engineer has an idea the adoption of which would apparently save his employer thousands of dollars and the chief engineer refuses to consider it, is the operator justified in going over the chief's head directly to the general manager?

A. L. W.

Suitable answers from readers will be paid for and published in the Feb. 5 issue.

PROFIT AND PRODUCTION *in Industry*

BY ALFRED J. T. TAYLOR

It would be the irony of fate if the Scotch, so often the butt of "thrift" jokes, should play a leading part in the application of the new thrift—spending to save. In this abstract of a paper recently presented before the "Institution of Engineers and Shipbuilders in Scotland," factory executives in America will find sound thinking on the relation of power, modernization and engineering to stable profits.

IT IS a commonplace truth, all the more important for being commonplace, that it was the application of a new source of power—steam—which a century ago opened the way to the vast expansion of industry that rapidly enabled this country to recover from the strains and wastes of the Napoleonic wars, and to go forward to undreamed of prosperity.

New sources of power are not in the least likely to be immediately revealed to us today, and consequently we must fall back on the exploitation of the sources we already have. As compared with America, the application of power generally is still backward in this country, but at least we are now making great strides forward.

The Census of Production Reports shows that the power equipment of the principal industrial groups increased between 1907 (the date of the first census of production) and 1924 (the date of the third census). In prime movers (other than locomotives) the increase was from 10,374,000 hp. to 16,419,000 hp., or nearly 58 per cent., while in electric generators the increase was from 1,704,000 kw. to 6,507,000 kw., or no less than 280 per cent. The fourth volume of the Report of the Balfour Committee states that power capacity "increased between 1907 and 1924 from something under eight million to something more than 13¾ million horsepower, that is, by about three-fourths."

It is thus clear that power is becoming of greater importance in industry than it has ever been before, and the inference I draw from this is that those who understand power, and can apply it and guide it, must also become of greater importance in industry.

"It is clear that power is becoming of greater importance in industry than it has been, and the inference I draw from this is that those who understand power and can apply it and guide it, must also become of greater importance in industry."

We must have more and better engineers in our industries, and they must occupy positions of greater executive authority in their respective plants before we can expect to attain anything approaching a satisfactory state of affairs in these industries, to say nothing of restoring them to the position upon which our greatness as an industrial nation depends.

Managers and owners of industrial plants who are inclined to regard the question of the efficiency of their plants as a private and personal matter are, to be frank, dangerously limited in their outlook, and those who fail to return a fair percentage of their earnings to the industry itself, in the form of plant improvement, are certainly doing the industry and their own pockets a great deal of harm.

They lose sight of the fact that, if they are to keep their forces continuously and profitably employed, they must be able to meet competitive conditions continuously. These competitive conditions, as our leading export industries have found out to their cost, are frequently set up by foreigners, and, among them, some who, as in America, are ruthless and insistent modifiers and improvers of industrial plants.

The vast increase in power used in industry surely implies two things—first, that existing machinery must be used with the greatest economy and efficiency, and second, that in every industrial plant the closest observation must be kept on all possibilities of plant improvement.

On both grounds it is plain that the importance of the function of industrial engineers is rapidly increasing, and this requires that their status in industry should be improved. Everyone knows, for example, that the application of machinery to warships, which began just a century ago, led very rapidly to the increasing importance of engineers in the Navy, and along with this came increasing recognition of their status. We want "engineer-admirals" in industry as well as in the senior service.

The management of an industrial plant has two major responsibilities. The one is to the shareholders, and the other to the employees. If the manager is also the owner, he cannot shirk the second responsibility, and the surest way to fulfill it is by so maintaining his works in a state of the highest efficiency that, in the face of the strongest competition from others, it may still be able to carry on profitably.

Speaking quite generally, it may be said that the annual financial provision for plant improvements in this country is so inadequate as to endanger efficient production. From works to works, as from industry to industry, this necessary annual provision for plant improvement naturally varies, but a fair average for the division of profits is to distribute one half in the form of dividends to shareholders and retain the other half as a reserve for extensions, research work and improvements to the plant.

In some industrial plants the necessities of the industry are entirely overlooked. Profits are distributed among the shareholders to the last penny, development, research, and modernization being disregarded. In consequence, the plant and the business fall behind: eventually, profits dry up and the employer and the employees are faced with disaster.

"Everyone knows that the application of machinery to warships, which began just a century ago, led very rapidly to the increasing importance of engineers in the Navy, and increasing recognition. We want 'engineer admirals' in industry."

You may see this condition even in industrial America, where there is less excuse than here for such grave and tragic errors. You may see there, in one of the older states, a mill located in a valley, while on a near-by hill is the ornate and pretentious mansion of the mill owner. The mansion was built

out of profits and cost more than the mill. Half that cost would have kept the mill equipped with modern machinery, capable of meeting the new competition. The mill was starved to build the mansion. Both are now closed, and the industry has departed never to return.

"Every director of large enterprises," say Professor Taussig, the economist, "must choose between competing mechanical devices, must watch the course of invention, must be in the fore with

"We must have more and better engineers in our industries, and they must occupy positions of greater executive authority before we can expect to attain anything like a satisfactory state of affairs in these industries, to say nothing of restoring them to the position upon which our greatness as an industrial nation depends."

improvements." This is a counsel of perfection. The time and energy of such a director are occupied by a mass of problems with which he is in fact able to deal, since he has the necessary experience and knowledge, but it is only in the rarest cases that he has either the experience or the knowledge, assuming that he has the time and the energy to spare, to enable him to switch his mind to the problems of industrial engineering.

Here is where the industrial engineer, if trusted with the execution of plans for economy and improvement, can play a great part. But if he is to do it effectively, he must be given greater authority than he has at present and have a share in knowledge from which he is usually excluded. He must be made familiar with the policies decided upon by the management, he must know the trend and results of the research work that has been carried on, and he must have a part in trying to interpret the trend of the industry and the probable line of its future development.

Industrial plants that have been neglected in good times usually become absolutely hopeless when times are bad, which is just when their efficiency should be at its highest. They become more or less obsolete, and so beyond rehabilitation at any reasonable cost, and wholesale scrapping or abandonment becomes the only alternative. There can be no doubt that obsolete plants, or at least plants below the margin of modern efficiency, are one cause of the loss of competitive power in overseas markets from which we are suffering.

Industrial groups have no moral or other right to appeal to government for protection until those concerned have fully tested out their own ability to meet outside competition. This can be done only by putting all plant equipment and factories in as up-to-date a condition as possible. The workpeople also must be acquainted with the position and asked to do everything they can to make their work effective. New methods and markets should be carefully studied, and full advantage taken of any favorable conditions. Then, and not till then, should the comparison with outside competition be made, and if it can be shown—honestly shown—that without protection the position is hopeless from a competitive point of view, then an appeal for government help would be justified.

In the industrial world, we *must* be ready for new developments. In every plant there must not only be an industrial engineer endowed with the skill and insight to adopt improvements, but the reserve capital necessary must also be made available by annual appropriations, as already described. It will, of course, be both the interest and the duty of those who direct any particular business to observe the due balance between different lines of expenditure, but at all times they must be ready for new developments. Any other frame of mind means industrial death.

As directors go round the plant, apt, it may be, to look complacently at their new installations of the most up-to-date machinery, they will do well to say to themselves, "This, too, will change." Competition will become more and not less keen as years pass by. The old rule of the survival of the fittest will prevail.

Since widespread social misery is the direct outcome of industrial inefficiency, those who are responsible for industrial management must not let things take this course. They must constantly be ready to investigate new processes and

"Even in industrial America . . . you may see, in one of the older states, a mill located in a valley, while on a near-by hill is the ornate mansion of the mill owner. The mansion was built out of profits and cost more than the mill. Half that cost would have kept the mill equipped with modern machinery. The mill was starved to build the mansion. Both are now closed."

inventions that affect their own business, and they must seek every ally and every colleague who can assist them to right conclusions, and in particular they must reflect on the fact that all the changes and tendencies of industry are obviously such as to make the functions and status of industrial engineers one of the vital points of success.

This country possesses all the necessary raw materials of prosperity—cheap coal, cheap transportation, cheap finance, a homogeneous population, and the best all-the-year-working climate in the world. All these advantages, coupled with the right and full use of the efficient technical assistance which is at our doors for the asking, should put our industrial enterprises in the vanguard of that era of prosperity which is their due, and which from all the signs that can be read is already within a measurable distance of attainment.

The industrial engineer has become, in my view, one of the most important factors in bringing about the return of the full all-round prosperity which we all ardently desire to see. Plant is such an important part of equipment, its capital cost is so large, and the interest and depreciation on it such serious elements in the cost of production, that the industrial engineer in control of it contributes as much as anyone to the efficient production which alone, under competitive conditions, results in profit making.

Recent Publication

AMERICAN PROSPERITY — ITS CAUSES AND CONSEQUENCES. By Paul M. Mazur. Published by The Viking Press, Inc., New York, 1928. Cloth; 268 pages. Price, $2.50.

JUST what underlies the unprecedented condition in the United States, continued prosperity with no periods of depression has caused much study and the publication of a number of stimulating books. The present work is of particular interest, for it gives the banker's view, Mr. Mazur having been engaged in banking in New York City for many years. The views it expresses, while differing considerably from those of other writers on the subject, sound the more practical note of one who has daily dealt with prosperity, rather than studied it from afar.

Foster and Catchings, and their school of thought, attribute present conditions largely to high wages, the continual recreation of a large purchasing fund in the hands of the ultimate consumer. Industrial and engineering views incline to credit the low cost and efficiency of mass production with the present state of affluence, looking on the inefficiency and high cost of sales and distribution as the only drawbacks in the present situation. Orthodox economists are in disagreement with both these views, looking to the abundance of capital for the source of wealth, although they do seem at a loss to discover how this capital is amassed. Mazur, in the present work, casts aside all these ideas and gives full credit for modern prosperity to the remarkable sales and distribution methods that enable industry to dispose of the enormous production now customary.

Probably the entire truth is not in any one of these analyses, but each contains part of the picture. In any case, Mazur's "American Prosperity" is a work of real value to the American industrialist and business man and should be read by all those who have not already done so.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

New York City Filled with Scientists as A.A.A.S. Holds Greatest Convention

Papers Run the Gamut from Curvature of Space to Fruit Flies—Two Sessions of Interest to Engineers

WITH Christmas tree candles scarcely extinguished and in spite of the intervention of Sunday and New Year's day, 4,900 members of the American Association for the Advancement of Science have just completed the seven arduous days of their annual meeting in New York City. The association, which transcends all others in the diversity of its interests, brought together every conceivable brand of ologist, from the potatologist to the interpreters of Einstein and the weather, a large proportion of whom read papers on subjects ranging all the way from microbes to infinity and including 1,500 way points in between.

The program of the meeting, crammed into a 292-page booklet and assisted by various supplementary texts issued by member societies, would reduce the ordinary type of convention document to the proportions of a calling card. In it was listed an astounding array of scientific topics, each given in the idiomatic language peculiar to its devotees, and all scheduled to be presented at some time during the week. For any man interested to the remotest degree in science or its discoveries there was sure to be a wealth of information available. If "Bryological Notes on Three Brachythecia Hard to Separate" failed to interest, there was the "Attachment of the Cyprid Larvæ of the Barnacle," and if this also fell short, there still remained such elementary considerations as "Prehistoric Basketry" or "Studies on the Sense of Humor of 100 Vassar Students." For those unable to enter into the serious spirit of scientific investigation there were numerous papers to be heard on subjects calculated to interest all. These included descriptions of the proposed 200-in. telescope, which will have a reach of 400 million light years, dissertations on the atom and the electron, a discussion of the possibility of increasing the average span of life, and many others. Excursions, teas, dinners, dances and theater parties also served to relieve the strain and shift the center of gravity of the week's work.

While the greater part of the convention's proceedings appeared to be in terms somewhat obscure to the average engineer, there were one or two sessions in which subjects of interest to *Power's* readers were brought up. These sessions were held by Section M, on engineering, which on one occasion devoted itself to a symposium on the chemistry of the metals. This included the following papers:

"The Microscopic Structure of Metallic Alloys," by F. F. Lucas; "Fatigue Strength and Elastic Strength of Metals," by H. F. Moore; "Chemical Specifications in the Metal Industry," by John Johnston; "Corrosion of Metals as Influenced by Surface Films," by F. N. Speller; and "Light Alloys in Aircraft Construction," by E. H. Dix, Jr.

Of these papers, that by Professor Moore was of particular interest. It pointed out that elastic failure of a metal involves the splitting up of crystalline grains of metal into thin plates and the sliding of these plates over each other. Fatigue failure involves the start and spread of a minute crack.

The atomic behavior of metals as they fail seems to show elastic failure as characterized by the breaking of atomic bonds in the metal, the establishment of new bonds, and a re-mating of atoms with new partners. Fatigue failure is pictured as the permanent failure of atomic bonds—a failure spreading from atom to atom, from grain to grain of the crystal.

To judge of the suitability of a metal for a structural purpose or machine part, it is necessary to have some knowledge of both its elastic strength and its fatigue strength; and, in addition, some knowledge of its ductility under bending and of its machinability.

Further activities of Section M were of interest on the afternoon of Dec. 29, when prominent engineers and scientists participated in a symposium on industrial research. Three aspects of "The Organization of Scientific Research in Industry" were discussed by F. B. Jewett, president of the Bell Telephone Laboratories; Willis R. Whitney, Research Director of the General Electric Company; and L. V. Redman, Director of Research, General Bakelite Corporation.

"It is not difficult," said Doctor Jewett, "to recruit the rank and file of research workers, but the selection of leaders—the real investigators—is something of a problem." The prime qualification for success in research, according to Doctor Jewett, is an overwhelming curiosity regarding nature.

Doctor Whitney, discussing research from the standpoint of the pay envelope, found a little fun in the suggestion that competent men needed encouragement. He defied anyone to discourage competent men. However, Doctor Whitney agreed with Doctor Jewett in stressing the importance of correct environment, ample space and working facilities.

Introducing Doctor Redman, the chairman, Dean Sackett, of Pennsylvania State University, called attention to the fact that any one of several industrial laboratories each spends more on research than all the colleges put together. He therefore wondered why a college professor, rather than Doctor Redman, had not been chosen to talk on the economic aspects of research.

Doctor Redman presented some interesting curves, showing that the long-time returns from research far exceed those from ordinary investments. But it was difficult, he said, to keep up the courage of those who hold the purse strings, through the early non-productive period. If funds are cut off at the end of five or six years, everything is lost, he said. Large research laboratories take care of this condition by always having researches in various stages of progress, so that the laboratory is showing a large net profit at all times.

At the close of the meeting a reception was held at the Museum of Peaceful Arts, 24 West 40th St., where the members became greatly interested in the operation of the mechanical and scientific models there displayed.

Most of the sessions were held in various lecture halls at Columbia University, although the overflow reached many other parts of New York and brought the engineers together at their usual headquarters at 29 West Thirty-ninth Street.

Coming News

The heating and ventilating engineers have announced their first international exposition, which will be held in Philadelphia in January, 1930. Although still a year in advance, 35 manufacturers have already applied for space in the exhibit hall. The first official announcement of the exposition will be discussed next week in these pages.

*Spot * News*

NEW YORK'S NEW GOVERNOR, *Franklin D. Roosevelt, pledges his active support to the cause of publicly owned water power. He remains vague as to whether the building of dams and power houses and the distribution of current will be delegated to private enterprises or carried out by the state itself.*

* * *

TURBINE-ELECTRIC DRIVE *for ships has received another convert in the person of the Pere Marquette Railroad. Two 18-mile-an-hour car ferries are planned by this company for service between the Michigan and Wisconsin shores of Lake Michigan—a run of 60 to 100 miles.*

* * *

LONDON BUSINESS OBSERVERS *are much encouraged by the unprecedented interest shown in the British Industries Fair to be held in London and Birmingham in February. The record number of exhibitors, they believe, presages a favorable upward turn for industry.*

* * *

A GROUP OF SEVEN *western New York utilities, among them the Buffalo General Electric Company and the Niagara Falls Power Company, have petitioned the state Public Service Commission for permission to consolidate into one large unit, to be known as the Niagara Power Corporation.*

* * *

A "WIFE SAVING STATION" *is the name under which an electrical appliance concern in Vincennes, Indiana, is appealing to the community to increase the power behind the housewife.*

* * *

PRESIDENT MAHAN *of the National Coal Association states that bituminous production in 1928 dropped 27 million tons below the figure for the year before. Mr. Mahan states that a large part of this falling off was due to the utilization of surplus stock on hand and to a drop in the export coal trade.*

* * *

NIAGARA FALLS *is again the subject of international conferences, since the maximum of treaty water is now being used. Negotiations have for their object the further diversion of water for power purposes and at the same time the rendering of assistance to mother nature in covering up some of the bare spots in the falls.*

* * *

TO LET THE SUN CATCH UP *in its duty of pumping water up into the Sierra Nevada Mountains after a season of little rainfall, the city engineers of San Francisco recently shut down the Hetch Hetchy power plant at Moccasin Creek, California. Revenue from the Pacific Gas & Electric Company, purchaser of the power, was thus lost at the rate of $4.50 a minute.*

A.I.E.E. Winter Convention Program Announced

Five-Day Meeting Will Start Jan. 28.

THE program of the winter convention of the American Institute of Electrical Engineers has just been announced, and contains five days of technical sessions, inspection trips, a smoker and other entertainment features. The meeting will be held in New York City, with headquarters at the Engineering Societies Building, at 29 West 39th St.

Forty-two papers are scheduled for presentation at the technical sessions, covering a wide range of subjects including circuit breakers, induction motors and other electrical machinery, measuring instruments and lighting. The sessions on the first two days of the meeting will be concerned with physics and transmission problems, but on the last three days a number of papers will be given which should be of considerable interest to readers of *Power*.

An outstanding feature of the program will be the ceremonies attending the presentation of the Society's two medals, the Edison and Lamme medals. This occasion has been set for Wednesday evening, Jan. 30. A smoker, which will be held on the previous evening, is designed to relieve the formality of the meeting and will include musical and humorous numbers presented by performers of note. The annual dinner dance will be held on Thursday evening, Jan. 31, in the ballroom of the Hotel Astor. The trips that have been arranged for the meeting include the Hell Gate Station of the United Electric Light & Power Company, the Bell Telephone Laboratories, the Hunts Point Gas plant, and a trip on one of the new Diesel-Electric ferryboats recently put in service in New York Harbor. Many other inspection trips are planned.

A partial list of the papers to be presented on the last three days of the convention follows:

WEDNESDAY MORNING SESSION
JANUARY 30

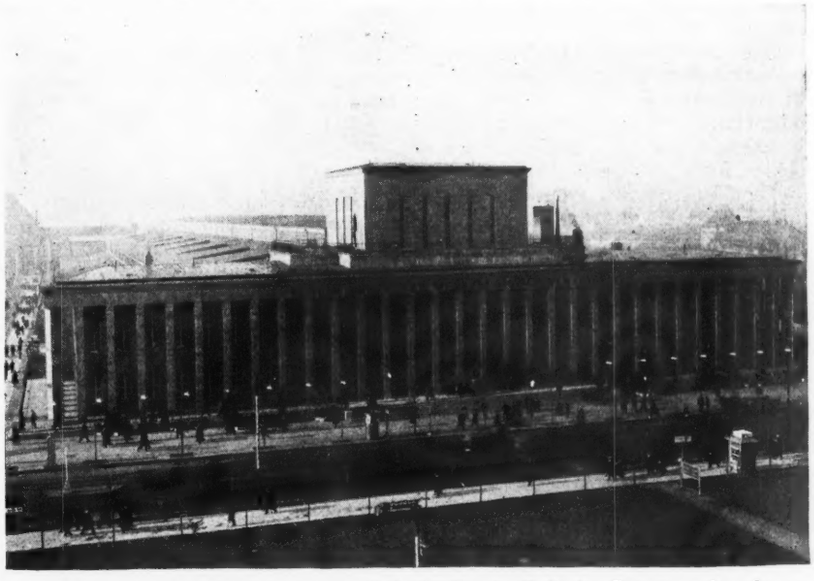
An oil-less heavy-duty circuit breaker —its theory, construction and test—is the subject of three papers planned for this session, and a fourth paper will be on automatically reclosing high-speed d.c. breakers. The papers are: "Theory of the Deion Circuit Breaker," by Joseph Slepian, Westinghouse Electric & Manufacturing Company; "Structural Development of the Deion Circuit Breaker," by C. R. Dickinson and B. P. Baker, Westinghouse Electric & Manufacturing Company; "Field Tests on the Deion Circuit Breaker," by B. G. Jamieson, Commonwealth Edison Company; "Automatic Reclosing High-Speed Circuit Breaker Feeder Equipment for D-C Railway Service," by A. E. Anderson, General Electric Company.

THURSDAY MORNING SESSION
JANUARY 31

The capacitor motor, low-starting-current induction motors, and calculation of no-load core losses are the subjects of the five papers planned for this session. Among these papers will be: "The Condenser Motor," by B. F. Bailey, University of Michigan; and "Line-Start Induction Motors," by C. J. Koch, General Electric Company.

THURSDAY AFTERNOON SESSION

Five papers are planned for this session, dealing among other things with insulation tests on electrical machinery before and after placing in service, and



FOR seven hundred years the Leipsic Trade Fair in Germany has been an industrial event to all of Europe. On March 3 the entire city will celebrate the 1929 Fair. The building above is Hall No. 9 of the German Tool Manufacturers' Association, and one of the largest exhibition buildings in the world.

the influence of temperature on commutators. These papers will include: "Insulation Tests on Electrical Machinery Before and After Being Placed in Service," by C. M. Gilt, Brooklyn Edison Company, and B. L. Barns, Canadian General Electric Company; and "Influence of Temperature on Large Commutator Operation," by F. T. Hague and G. W. Penney, Westinghouse Electric & Manufacturing Company.

FRIDAY MORNING SESSION
FEBRUARY 1

Measurements of fluid flow and the study of noises in electrical apparatus are among the subjects to be covered. The papers include: "Measurements of Flow by Use of Electrical Instruments," by W. H. Pratt, General Electric Company; and "Study of Noises in Electrical Apparatus," by Thomas Spooner and J. P. Foltz, Westinghouse Electric & Manufacturing Company.

FRIDAY AFTERNOON SESSION

Totalizing meters, remote metering, high-accuracy current transformers, and a precision regulator for alternating voltage, are among the subjects of this session. The papers include: "Telemetering," by C. H. Linder, H. B. Rex and C. E. Stewart, General Electric Company; "Totalizing of Electric System Loads, by P. M. Lincoln, Cornell University; "A New High-Accuracy Current Transformer," by M. S. Wilson, General Electric Company; and "A Precision Regulator for Alternating Voltage," by H. M. Stoller and J. R. Power, Bell Telephone Laboratories.

Heat Transmission Committee Active

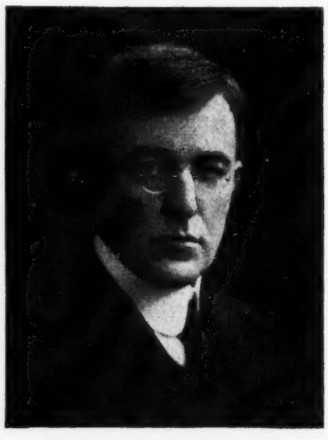
W. V. A. Kemp, director of the Committee on Heat Transmission of the National Research Council, recently issued a statement on the work of the committee during 1928 and the program for the new year. The outstanding accomplishment was the rendering of the fundamental report on definitions, nomenclature, symbols and units, issued by subcommittee "C", and published in booklet form for general distribution. The booklet contains twelve pages, in which are stated the fundamental laws of heat transmission, and the formulas in which these laws are written. A discussion of nomenclature and units is also included, together with conversion tables and a table of symbols.

In addition to the report four other subcommittees have been at work on test codes covering insulation in the low, intermediate and high temperature fields and electrical insulation. A directory of experimental research in educational institutions is also in preparation, together with texts on the promotion of heat transfer and on heat insulation.

The outstanding feature of the work of the new year will be the establishment of three research fellowships of two years each in three selected educational institutions, provided funds for the purpose can be raised. The objective of these will be the experimental determination of the laws relating heat transfer to various physical properties of liquids, and it is felt that the results will be of great importance to both manufacturers and users of such equipment as surface condensers, feed-water heaters, oil and water heat exchangers and the like. The design of apparatus necessary for conducting these experiments has already been completed by the subcommittee on the promotion of heat transfer.

Chemical Society Elects Langmuir President

Dr. Irving Langmuir, associate director of the Research Laboratory of the General Electric Company, Schenectady, N. Y., has been elected president



Dr. Irving Langmuir

of the American Chemical Society for 1929. He succeeds Prof. Samuel W. Parr, of the University of Illinois.

Doctor Langmuir was born in Brooklyn, N. Y., Jan. 31, 1881, and was graduated from the School of Mines of Columbia University in 1903. He received the degree of doctor of philosophy from the University of Göttingen, Germany, in 1906, and after a period as an instructor at the Stevens Institute of Technology, he entered the General Electric Research Laboratory in 1909.

Notable among his achievements since, is his invention of the nitrogen or gas-filled incandescent lamp, and of the pliotron and kenotron, devices highly advantageous in radio and wireless telephony, and fundamental to the perfection of the Coolidge X-ray tube. Growing out of these experiments with gas-filled tubes came the discovery of the atomic hydrogen arc, which Doctor Langmuir assisted in developing to the commercial stage for electric welding purposes.

Civil Engineers to Hold Annual Meeting

The American Society of Civil Engineers will hold its seventy-sixth annual meeting Jan. 16-18 in New York City, the program for which has just been distributed. The headquarters of the meeting will be in the Engineering Societies Building, 33 West 39th St.

Coming Conventions

American Boiler Manufacturers Association, mid winter meeting, Cleveland, Ohio, Feb. 5, 1929. A. C. Baker, secretary, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers, annual winter convention, New York City, Jan. 28-Feb. 1; annual summer convention, Swampscott, Mass., June 24-28; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, 35th annual meeting, Chicago, Ill., Jan. 28-31, 1929. A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Calvin Rice, secretary, 29 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Engineering Institute of Canada, annual general and professional meeting, at Hamilton, Ont., Feb. 13-15, 1929. R. J. Durley, secretary, 2050 Mansfield St., Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; Conference headquarters at the Palmer House, Exhibition at the Coliseum; G. E. Pfisterer, secretary 53 West Jackson Blvd., Chicago.

National Marine Engineers Benefit Association. The 54th annual meeting will be held in Washington, D. C., Feb. 11-16, at the Hotel Hamilton.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

A large part of the technical sessions will be taken up with papers and discussions on structural, sanitary and highway engineering. One paper, to be given during the afternoon session of the construction division, Jan. 17, should be of interest to *Power's* readers. This will be "On Hydro-Electric Work," by W. L. Locke, vice-president, Stone & Webster, Inc., Boston, Mass.

There will also be a power session on Thursday afternoon, Jan. 17. At this session a report of the committee on "Ice as Affecting Power Plants" will be presented; a paper on the "Rocky River Power Development," by J. D. Justin, of the United Gas Improvement Company, Philadelphia, will be given; and a general discussion will be held. The discussion will be opened by George A. Orrok, consulting engineer, and W. K. Freeman, of the New England Power Construction Company, Boston, Mass.

Excursions will be made to various structural projects near the city.

With the Society Sections

American Engineering Council, annual meeting, to be held in Washington, D. C., Jan. 14-15, 1929, at the Mayflower Hotel.

A. S. M. E., Anthracite-Lehigh Valley Section. Meeting at Reading, Pa., Jan. 18. Subject: "Burning Anthracite"; speaker not yet announced.

A. S. M. E., Colorado Section. Joint Meeting, Jan. 11, with the civil and electrical engineers. Subject: "Electric Welding," by F. P. McKibben.

A. S. M. E., Knoxville Regional Meeting, Mar. 21-23, 1929. Technical program and trips to points of interest.

A. S. M. E., Metropolitan Section, New York City. Joint meeting, Jan. 8, with the American Welding Society. Subjects: "Training and Management of Welding Operators for Pressure Piping and Vessels," by H. H. Moss, Linde Air Products Co., and "The Present and Future of Welding in Power Plants," by P. W. Swain, Managing Editor, *Power*.

A. S. M. E., Metropolitan Section. Meeting on Jan. 11, in New York City. Subject: "The Development of Present Day Combustion Control," by R. J. S. Pigott, Smoot Engineering Company.

A. S. M. E., Metropolitan Section. Joint meeting on Jan. 14 with the Woman's auxiliary, A. S. M. E., at which the premier showing will be made of the official film of the World Engineering Congress, Tokyo, Japan.

A. S. M. E., New Britain, Conn., Section. Meeting at Hartford, Jan. 14. Subject: "The Relation of Research to Modern Engineering Progress," by Charles E. Kettering, vice-president of the General Motors Corporation.

A. S. M. E., Oregon Section. Portland, Oregon, Jan. 25. Subject: "Lubrication of Internal Combustion Engines," by Prof. F. C. Baender, Corvallis, Ore.

A. S. M. E., Syracuse, N. Y., Section. Meeting, Jan. 14. Subject: "Mercury Vapor Process for Power Generation," by Dr. B. L. Newkirk, General Electric Research Laboratories.

A. S. M. E., Washington, D. C., Section. Meeting, Jan. 17. Subject: "The Holland Tunnel," by H. R. Sewell, B. F. Sturtevant Company. This talk will be given with special reference to the ventilation problems of the tunnel.

American Water Works Association, Kentucky-Tennessee Section. Annual meeting, to be held at Chattanooga, Tenn., Jan. 24-26, 1929.

Engineers' Club of St. Louis. Meeting Feb. 13, 1929. Subject: "Steam Storage and Steam Distribution," by R. A. Longworthy, vice-president and general manager of Ruths Accumulator Company.

Personals

J. N. Landis, formerly plant equipment engineer of the Brooklyn Edison Company, Brooklyn, N. Y., has been appointed assistant mechanical engineer of that company. He will be associated with G. L. Knight, who is head of the mechanical engineering department.

H. L. R. Emmet has been appointed manager of the Erie, Pa., works of the General Electric Company, and J. E. Brobst has been named manager of the Bloomfield, N. J., plant of the same company, succeeding Matthew Griswold at Erie and C. D. Knight at Bloomfield, both of whom retired from active service on Jan. 1 because of ill health.

Joseph Drake, formerly boiler-room engineer at the Trenton Channel plant of the Detroit Edison Company, is now steam-production engineer at the State Line generating station at State Line, Indiana.

George Orrok has now established a consulting engineering practice in New York City. His office will be at 52 Vanderbilt Ave.

D. M. Archer, engineer, formerly with Webster Tallmadge & Company, Incorporated, has now joined the engineering department of the Sarco Company, Incorporated, New York City.

H. H. Dewey, until recently assistant engineer of the central-station department of the General Electric Company, Schenectady, N. Y., has been appointed as vice-president of the International General Electric Company.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.35@$2.40
Kanawha.....	Columbus.....	1.25@1.45
Smokeless.....	Cincinnati.....	2.25
Smokeless.....	Chicago.....	2.25
S. E. Kentucky...	Chicago.....	1.35@ 1.60
Steam.....	Pittsburgh.....	1.60@ 1.70
Gas Slack.....	Pittsburgh.....	.75@ .90
Big Seam.....	Birmingham...	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2.75@$3.25
Barley.....	New York.....	1.25@ 1.75

FUEL OIL

New York—Jan. 3, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4⅜c. per gal.; 36@40 deg., furnace, tank-car lots, 6½c. per gal.

St. Louis — Dec. 26, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.37½ per bbl. or 42 gal.; 26@28 deg., $1.42½ per bbl.; 28@30 deg., $1.47½ per bbl.; 30@32 deg., $1.52½ per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., distillate, 5.375c.

Pittsburgh—Dec. 24, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5¼c. per gal.

Philadelphia—Dec. 29, 13@19 deg., $0.95@$1.02 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 26@30 deg., $2.00@$2.06 per bbl.

Cincinnati — Dec. 29, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Dec. 29, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 72½c. per bbl.; 30@32 deg., 97½c.@$1 per bbl.

Boston—Dec. 31, tank-car lots, f.o.b. 12@14 deg. Baumé, 4½c. per gal.; 28@32 deg., 5.6c. per gal.

Dallas—Dec. 22, f.o.b. local refinery, 26@30 deg., $1.20 per bbl. or 42 gallons.

Business Notes

The General Refractories Company of Philadelphia, Pa., has opened a new district sales office in Boston, Mass., Room 509, Marshall Building, 40 Central St. The office will be in charge of Nelson W. Bowman, formerly of the New York office of the company.

The Hollow Center Packing Company, of Cleveland, Ohio, announces the opening of a branch office at 321 Broadway, New York City.

The Wagner Electric Corporation of St. Louis, Mo., announces the addition of N. H. Spencer to its Dallas, Texas sales force. Mr. Spencer's experience in the electrical field covers a total of some twenty years, during which time he held several managerial positions with other companies.

The Brown Instrument Company announces that its office in New York City will in future be at Room 1502, Roebling Building, 117 Liberty St., removing from 50 Church Street.

The Bernitz Furnace Appliance Company, Boston, Mass., announces the removal of its main office from 80 Federal St. to much larger quarters in the new Public Service Building at 89 Broad St., that city.

Trade Catalogs

Diesel Engines—In Bulletin 774, just off the press, the Chicago Pneumatic Tool Company, New York City, gives a general description of the Benz Diesel it is manufacturing. The catalog is embellished with many illustrations of engine parts.

Ash Handling—Catalog No. 1228, issued by the Allen-Sherman-Hoff Company, Philadelphia, Pa. devotes 24 pages to a description and illustration of its Hydrojet apparatus. There are numerous views of installations, details of special features, reproductions of blueprints and general descriptive text.

Compressors—In a new bulletin on this subject the Ingersoll-Rand Company, New York City, devotes twenty pages to a discussion of its Type "XG" direct-connected gas-engine-driven compressors. Photographs of installations and of various parts of the machines are included.

Induction Motors—Bulletin 1087-F, issued by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis., gives in sixteen pages of text and illustration, some general information regarding a line of large polyphase induction motors.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Mobile—City is having plans prepared for the construction of a water and light plant. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., are engineers.

Ark., Pine Bluff—Bd. of Education, J. P. Womack, Secy., State Capitol Bldg., Little Rock, will receive bids until Jan. 10 for the construction of a group of school buildings including power house, etc., for State Agricultural, Mechanical and Normal School for Negroes. Estimated cost $350,000. Thompson, Sanders & Ginocchio, Hall Bldg., Little Rock, are architects.

Calif., Orange—Santiago Orange Growers Assn. awarded contract for the construction of an ice and pre-cooling plant and packing plant to Gay Engineering Corp., 2650 Santa Fe Ave., Los Angeles. Estimated cost $150,000.

Colo., Delta—C. Viestenz, Loveland, is having plans prepared for the construction of a steam electric generating plant here. Private plans.

Conn., Hartford — S. Max & Co., 38 Church St., is having plans prepared for the construction of an electric cold storage plant for fur storage. Estimated cost $65,000. Berenson & Moses, 252 Asylum St., are engineers.

Ind., Anderson—Indiana-General Service Co., Muncie, is having plans prepared for the construction of new power sub-station here. Estimated cost $300,000 to $5,000,000.

Ind., Fort Wayne—City, J. W. Grodrian, Supt., awarded contract for the construction of a municipal power plant on North Clinton St., to Henry Wehrenberg & Son, 618 South Clinton St. Estimated cost $300,000.

Kan., Prairie View—City, B. Finch, Clk., awarded contract for waterworks improvements, including pump house, tank on tower, etc., to Roy Knox Construction Co., Clyde, Kan. Estimated cost $17,000.

Mass., Chelsea (Boston P. O.)—Boston Ice Co., 110 State St., Boston, will soon award contract for the construction of an ice storage plant at Spruce and Maple Sts., here. C. L. Weir, 41 East 42nd St., New York, N. Y., is engineer.

N. J., Atlantic City—Hotel Mayfield, c/o M. Ellis, Ellis Hosiery Co., 419 Arch St., Philadelphia, Pa., is having revised plans prepared for an 18 story hotel including steam heating, ventilation and refrigeration systems, boilers, elevators, etc., at Boston Ave. and Boardwalk here. Estimated cost $1,500,000. L. I. Brooks, 65 Madison Ave., New York, is architect. T. Golding, 597 5th Ave., New York, is engineer.

N. Y., New York—Manhattan Refrigerating Co., T. A. Adams, Pres., 525 West St., will soon receive bids for the construction of a refrigeration plant. G. Aus, 244 Madison Ave., is engineer.

N. C., Albemarle—Ives & Davidson Co., 15 Park Row, New York, N. Y., have acquired the Almond Light and Power Co.'s holdings here and is having surveys made for extensions and improvements to light and power plant, also transmission lines throughout Stanley county.

N. C., Louisburg—Louisburg College, A. W. Mohn, Pres., plans the construction of a group of college buildings including heating plant, etc. Estimated cost $1,000,000.

O., Cleveland—Cuyahoga Cold Storage Co., L. Malbin, 3542 Croton Ave., is having plans prepared for an 80 x 80 ft. cold storage warehouse. Estimated cost $150,000. A. A. Soffen, Engineers Bldg., is engineer.

S. D., Watertown—City plans to vote on $150,000 bond issue for extensions and improvements to municipal light and power plant including 1,500 kw. generating unit.

Tex., Nacogdoches—Pure Milk & Ice Co., S. B. Hayter, will receive bids in January for the construction of a milk and ice plant to include refrigeration for milk, small ice machinery plant for manufacturing ice, etc. Private plans.

Tex., Raymondville — Willacy County Water Control & Improvement Dist. 1, W. T. Holder, plans an election Jan. 14 to vote $7,500,000 for the construction of an irrigation project including pumping plants, etc. J. E. Johnson is county engineer.

Tex., San Benito — Barreda Irrigation Dist. plans the construction of a pumping plant, etc., in connection with proposed irrigation project. Estimated cost $1,000,000. V. E. Conrad, Brownsville, is engineer.

Wis., West Allis — City, J. L. Ferebee, Comr., plans extensions and improvements to waterworks including booster pumps, mains, etc. Estimated cost $62,200.

N. B., Moncton—G. Whittaker, Montreal, Que., plans the construction of a cold storage plant here. Estimated cost $500,000. Sargent, Howard, Latourelle Ltd., 6 Craig St. W., Montreal, Que., are engineers.

Ont., Queenston—Hydro Electric Power Commission of Ontario, 190 University Ave., Toronto, plans the installation of a 65,000 hp. unit in Queenston power plant. Will consist of extension to gate and power house, penstock, etc. Estimated cost $5,000,000. F. A. Gaby, 190 University Ave., Toronto, is engineer. Canadian Westinghouse Co., Hamilton, awarded contract for generator.

Ont., Sault Ste Marie—B. F. Avery, c/o Abitibi Power & Paper Co., will receive bids until Feb. 1 for the construction of a 5 story hospital including steam heating and mechanical refrigeration systems, etc., on Brock St. C. C. Woods, Imperial Bldg., Sarnia, is architect.

Ont., Toronto—Flint Paint & Varnish Co., Perth Ave., plans the construction of a boiler plant, stack and warehouse on Perth Ave. Estimated cost $150,000. Engineer not selected.

Ont., Windsor—International Ice & Cold Storage Co., 905 Mercer St., is having plans prepared for the construction of an ice and cold storage plant at Hanna and Mercer Sts. Estimated cost $1,000,000. Dangerfield & Winters, Huron and Erie Bldg., are engineers.

Equipment Wanted

Boiler House Equipment—Bryant Pattern & Mfg. Co., 201 Glengarry Ave., Windsor, Ont., equipment for boiler house, etc., for proposed 85 x 90 ft. plant. Estimated cost $30,000.

Boilers, Ice Machines, etc.—Western Produce Co., c/o R. White, Pres., and Gen. Mgr., Lubbock, Tex., two 80 hp. boilers, ice machines, etc. for proposed produce house and creamery at 4th St. and Ave. K. Estimated cost $200,000.

Pumps—City of Brantford, Ont., plans to purchase electric pumps, etc. for proposed waterworks filtration plant. Estimated cost $400,000.

Pumps—City of Swansea, Ont., plans to purchase electrically driven pumps for proposed sewage disposal plant and pumping station. Estimated cost $125,000.

Pumps—Town of Ingersoll, Ont., plans to purchase pumps, etc. for proposed waterworks improvements. Estimated cost $50,000.

Pumps—Town of Tecumseh, Ont., plans to purchase new electric pumps, etc., for proposed waterworks improvements. Estimated cost $50,000.

Pumps, Engines, etc.—City of Kitchener, Ont., plans the installation of Diesel driven pumps and 350 to 700 hp. engines for proposed waterworks pumping station. Estimated cost $30,000.

Pumps, etc.—City of North Bay, Ont., plans to purchase electric centrifugal pumps, etc. for proposed extensions and improvements to waterworks. Estimated cost $300,000.

Refrigeration Equipment—Anaheim Co-Operative Citrus Assn., Anaheim, Calif., refrigeration equipment for proposed pre-cooling plant. Estimated cost $85,000.

Industrial Projects

Ala., Gadsden — TIRE and RUBBER PLANT and POWER HOUSE—Goodyear Tire & Rubber Co., A. H. Zieske, Asst. Mech. Engr., East Market St., Akron, O., is having plans prepared for the construction of three factory units, 400 x 560, 100 x 400 and 100 x 400 ft., 1, 2 and 3 story, including power house, here.

Ind., Valparaiso—FACTORY and BOILER HOUSE—Fibroc Insulation Co., will soon receive bids for the construction of a 1 story, 112 x 350 ft. factory and boiler house. Estimated cost $400,000. Lockhart & Felt, South Bend, are architects.

Mich., Detroit — OIL REFINERY and POWER HOUSE—White Star Refining Co., 903 West Grand Blvd., is having plans prepared for the construction of an oil refinery including power house, etc., on Allen Rd. Estimated cost $3,000,000. A. McKee Co., 2422 Euclid Ave., Cleveland, O., is engineer.

N. Y., Laurel Hill—COPPER SULPHATE REFINERY—Nichols Copper Co., awarded contract for the construction of a copper sulphate refinery at Hobson and Halle Aves. Estimated cost $150,000.

O., Cleveland—AXLE and SPRING FACTORY—Eaton Axle & Spring Co., C. J. Ochs, Pres., East 65th St. and Central Ave., had plans prepared for the construction of a 1 story, 51 x 130 ft. factory at East 69th St. and Central Ave. Estimated cost $40,000. G. S. Rider Co., Century Bldg., is architect.

O., Cleveland — BRASS FOUNDRY — Sterling Brass Co., S. L. Weil, Pres., 9600 St. Catherine Ave., awarded contract for a 3 story, 44 x 144 ft. addition to factory to J. Miller, 10819 Drexel Ave. Estimated cost $60,000.

O., Elyria—MACHINERY FACTORY—Cleveland Automatic Machine Co., H. W. Ruppel, Gen. Mgr., 2269 East 65th St., Cleveland, plans the construction of a factory, here. Estimated cost $150,000. Architect not announced.

O., Euclid — STAMPING FACTORY — Geometric Stamping Co., D. R. Jones, Pres., 221 East 131st St., Cleveland, awarded contract for a 1 story, 250 x 600 ft. factory on Chardon Rd. to Austin Co., 16112 Euclid Ave. Estimated cost $600,000.

Pa., Ambridge — PIPE PLANT — A. M. Byers Co., Clark Bldg., Pittsburgh, is having preliminary surveys made for the construction of a group of buildings for pipe plant, here. Estimated cost $20,000,000. H. A. Brassert & Co., 310 South Michigan Ave., Chicago, Ill., are engineers.

Pa., Ambridge—TUBE MILL ADDITION —Standard Seamless Tube Co., is having plans prepared for a 1 story addition to tube mill. Estimated cost $500,000. H. M. Wharton, c/o owner, is engineer.

Pa., North Wales — AUTOMOBILE BODY PLANT — Baily Mfg. Co., 2336 Vine St., Philadelphia, plans the construction of a 1 story, 50 x 200 ft. automobile body plant, here. L. W. Levin, 1011 Chestnut St., Philadelphia, is architect.

Tex., Odessa — POTASH REFINERY PLANT—American Potash Co., c/o Chamber of Commerce, plans the construction of a potash refinery plant 2,000 raw product daily capacity in Ector County near, here. Estimated cost $250,000. Private plans.

Wis., Milwaukee — FOUNDRY EQUIPMENT FACTORY — Milwaukee Foundry Equipment Co., 284 7th Ave., awarded general contract for the construction of a 2 story, 70 x 120 ft. factory on South Pierce St. to E. Steirgerwald & Sons, Inc., 5310 State St.

Ont., Kitchener — AUTOMOBILE TIRE FACTORY—Canadian Goodrich Co., J. R. Jordan, Mgr., awarded contract for addition to automobile tire factory to Dunker Bros., 58 Louisa St. Estimated cost $250,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICES of electrical supplies have shown steadiness during the last two weeks. In the first half of December, however, there were several important changes in this group; most of them advances. In power-plant supplies, fluctuations of the last month involved minor items, such as wiping cloths, linseed oil, babbitt metal and rivets. The minimum on rivets, boiler and structural, is up 10c., to $2.90 per 100 lb., base, Pittsburgh. White wipers are down 1c., to 16c. per lb. at Chicago. Linseed oil prices are lower by 0.2c. per lb. at Western centers. Babbitt metal, highest grade, declined 2½c., to 67c. per lb., at New York warehouses, during the last month.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply.... $0.30	4 ply.... $0.36	

Steam—Discounts from List

First grade	40%	Second grade	45%	Third grade	50–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30–10%
Heavy	30–5%

RAWHIDE LACING—For cut, best grade, 30–5%; 2nd grade, 45–5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30–5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¼ in.	$0.90
Asbestos for high-pressure steam, ¼ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@$2.35 per bbl. without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots of 250 to 2,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago	$0.16
New York	.16@.16½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.108	$0.11	$0.11

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including ⅞-in. dia., list (Apr. 1, 1927) less 50-10% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill..... $2.90

Cone-head boiler rivets,, ½-in., per 100 lb.:
New York..... $5.00* Chicago... $3.60 Pittsburgh mill..... $2.90

*Price is for full packages; broken package lots, $6.50 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	67.00
Commercial genuine, intermediate grade	53.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.25

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv	Inches	Iron Black	Iron Galv
1 to 3	62%	50½%	1 to 1¼	30%	13%

LAP WELD

2	55%	43½%	2	23%	7%
2½ to 6	59%	47½%	2½	26%	11%
7 and 8	56%	43½%	3 to 6	28%	13%
9 and 10	54%	41½%	7 to 12	26%	11%
11 and 12	53%	40½%			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60%	49½%	1 to 1½	30%	14%
2 and 3	61%	50½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53%	42½%	2	23%	9%
2½ to 4	57%	46½%	2½ to 4	29%	15%
4½ to 6	56%	45½%	4½ to 6	28%	14%
7 and 8	52%	39½%	7 and 8	21%	7%
9 and 10	45%	32½%	9 to 12	16%	2%
11 and 12	44%	31½%			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1½			$17.07
1¾			19.20
1"		$38.00	17.92
1¼		28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3½	30.25	49.50	30.67
3¾	31.50	52.75	33.33
4	38.03	67.00	40.11

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2½ and 2¾ in.... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$31.00 (net)	$45.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	35%
1,000 to 5,000 ft.	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 4 per cent. additional.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
½	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$18.00
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		13.00
No. 16 cotton reinforced light		18.00
No. 18 cotton Canvasite cord		14.60
No. 16 cotton Canvasite cord		16.90
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$70.80	*76.70
No. 14 super service cord or similar (2 wire) in 1,000 ft.	106.20	*115.05

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard Package, 64%; standard package, 70%

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons	26%
Ten unbroken cartons	42%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	42%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt General Watts	Type	Price Each	200—260 Volt Special Watts	Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.22	....	....	....
60	A 21	.22	...	....	....
100	A 23	.35	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.10	$8.30	$10.25	$17.80
12	9.20	10.80	12.70	23.00
10	12.60	14.40	16.50	30.50
8	18.30	20.10	21.40	42.10
6	.....	.....	32.50	.....
4	.....	.....	45.00	.....
2	.....	.....	63.80	.....
1	.....	.....	86.20	.....
0	.....	.....	103.00	.....
00	.....	.....	124.30	.....
000	.....	.....	148.00	.....
0000	.....	.....	180.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots	29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots	31c. per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots	31c. per lb.
Soldering paste, 2 oz. cans		$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	35%
$50.00 list value or over	40%